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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of over 700 men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are THREE dollars. Associate membership is open to firms or agents of firms engaged in dealing in water works supplies. The initiation fee for Associate membership is TEN dollars, and the annual dues FIFTEEN dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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ERRATA.

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Page 20, bottom line, under "Location," for "Yantic River" read "Potapsco River."

Page 114, 12th line, and

Page 115, 16th line, omit the following sentences: "Daniel S. Brinsmade valued the power alone at $18 000 to $20 000. A fair value would be, perhaps, $32 000."

NEW ENGLAND WATER WORKS ASSOCIATION.

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GOVERNMENTAL REGULATION OF WATER POWERS.

BY MARSHALL O. LEIGHTON, CHIEF HYDROGRAPHER, UNITED STATES GEOLOGICAL SURVEY.

[Read January 12, 1910.]

Up to the time of long-distance transmission of electricity a water power was essentially a local agent of production. The energy derived was used at the site and the plant was practically a private affair. Long-distance transmission, however, made water power a public utility in every sense of the term, for it entered a public market and developed a public use. Although the term *public utility* has never been strictly defined in a way that is applicable to all times and cases, the legal principle is well established. The term implies that the public, in its sovereign capacity, retains the right of regulation and control, in a greater or less degree, over the exercise of any function of public consequence. When the owner of a private utility devotes it to a use in which the public has an interest, he, in effect, grants that public interest and, therefore, must submit to control by the public for the common good, to the extent of the interest that he has thus created. Public use is absolutely defined by the controlling conditions of the time. That which is *juris privati* to-day may be a public utility to-morrow.

Hydro-electric power, transmitted over a great area, becomes a common source of energy just as a railroad becomes a common carrier. We admit readily that a railroad is a public utility, but will it be contended that common facilities for production are

any less important to public interest than common facilities for transportation? One is merely the complement of the other. Viewed from every angle, the two are identical in economic principle.

Public utility with respect to transportation facilities has been recognized in appropriate legislative acts. Public utility with respect to water power is not generally realized in this country. It is true that for many years a water power supplying energy for mills has, under interpretation of the courts, been considered a public utility, but the principle was limited in its application, and its real significance has not been appreciated. We are now facing the mature problem, and our legislative program with reference to it is hardly begun. In the most of our states, water powers are on the same legislative basis that they were years ago. The gravity of the situation has been recognized in some European countries, and in a few of the states preliminary steps have been taken.

The consequences are not entirely internal. Water-power development has become a national policy in Europe. This cannot fail to attract great industries. The water-power sites of Europe are situated close to the great markets of the world. Is there any one in the United States so confident of this country's industrial leadership as to assert that the wholesale development of those large and cheap European powers will not seriously affect our status? Trade and production are entirely cosmopolitan. The cheapest and best source of energy is going to be used, if other local conditions are favorable, without reference to any particular flag. This country has now no policy worthy of the name, and it must either meet the situation or give way to those countries that have well-defined policies.

I am in no sense a socialist. Government ownership, and especially government operation of utilities, have not, in general, commended themselves to me. But I believe that there is a world of logic in a proposal to declare by legislative enactment that all water powers are of immediate or ultimate public utility, and to govern them accordingly for the common good.

There are two sides to all questions. It should be remembered by the many advocates of government intervention that regulation and control of water-power development must not mean

repression. Hydro-electric properties have not, as a class, returned to the investor a concourse of swollen dividends. The industry has hardly passed its experimental stages. It is profitable or unprofitable according as its expenses of development and maintenance, its market and its water supply, are favorable or otherwise. No industry will respond more readily to ill-advised and oppressive legislation. In none must the burden fall more directly on the ultimate consumer. A surprisingly large number of hydro-electric developments either fail to pay dividends or become bankrupt during the first decade of existence.

There is, however, a prospective internal menace in the present situation. Current periodicals announce the formation of a water-power monopoly that promises to impose unreasonable burdens on the consumer. These accounts, when shorn of their purely spectacular features, contain a certain element of truth. Some large consolidations of water-power interests have taken place during the last few years. This, together with the appearance of the names of a few persons among the officers or in the directorate of a large number of companies operating water-power plants, making new installations, or manufacturing or marketing water-power or electric machinery, point unmistakably, if not to a water-power trust, to a concentration of ownership and administration in several groups. These groups, in the usual course of events, may consolidate or at least effect a mutual agreement. Now, the menace in such a prospect lies not so much in the probability as in the possibility of unrighteous manipulation of the public interest. The menace is, therefore, speculative, but this fact does not relieve the necessity for legislation. The nation and the states are accustomed to legislate against speculative crimes and abuses because they know from past experience that, in the present state of society, mankind is frail.

Notwithstanding all this, we must recognize the fact that consolidation is inevitable. The natural laws governing stream flow, which man cannot change if he would, make water power a natural monopoly. This is another result of electrical transmission. When a water power is utilized at the site, there is no administrative reason for the consolidation of several widely separated privileges. Under modern development the energy is

distributed over a large area. In this large area there is a common demand for power, and the whole market constitutes an administrative unit. The demand of the region is a demand in the aggregate. At the outset that demand may be supplied by the energy developed at one site on one stream. As the demand increases with the continued development of industry, the task of supplying it from one fluctuating stream grows more difficult. The energy developed at several sites or on several streams must be transmitted to supply the market. Finally, all sources of power available for that particular field of demand must be brought under a common administration so that at any time the energy may be turned hither and yon to meet the requirements of each hour. Therefore, we cannot prevent the formation of a water-power trust, and we would not prevent it if we could. No one will deny that water-power consolidation secures distinct and unusual economies and, if the consumer receives the benefit therefrom, he is better off under consolidation. Therefore, the proper solution of the problem must lie in the legislative regulation of water-power development and maintenance, to the end that the consumer shall pay a fair and reasonable price for power, consistent with the production of fair and reasonable earnings on the capital invested.

So much by way of generality. It is easy to decide that water power, being a public utility, should be subject to public regulation. It is quite another matter to frame a law or draft a code of regulations that will accomplish only laudable purposes.

Many difficulties are occasioned by the common law of riparian rights, which provides that the usufruct of water is appurtenant to the adjoining lands. The doctrine is proving less and less satisfactory as our civilization becomes more complex. Our western states are fortunate in having adopted the law of prior appropriation, based on beneficial use. The common law is in conflict with, and must surely postpone, the complete solution of the water-power problem. It substantiates every whimsical and malicious individual claim, to the utter disregard of the common good. Our western states will find it easy to solve their future water-power problems. The eastern states will eventually abrogate the common law.

Among the provisions in recent European water-power acts and legislative proposals are the following:

1. Water-power development is subject to limited concession or franchise, and its disposal is determined according to relative beneficial use. This means that the highest bidder for franchise is not successful unless his proposed use be of the greatest public utility.

2. Charges for power are regulated directly or indirectly, so that they will be equitable and discriminate.

3. A suitable rental or fee is demanded.

4. The franchise or concession may be redeemed by the government on suitable notice and proper indemnity.

5. The conveyance insures to the consignee the usufruct of rights previously acquired by other parties, but unutilized at the time of making the new grant.

There are divers other provisions, but the foregoing are all that require mention at this time.

The questions of rates and rentals provoke the widest disagreement and seem to be the most difficult of solution, as they directly affect the earnings of any plant and are theoretically a tax upon its prosperity.

Who shall say offhand what is a reasonable rate of income on a water-power investment? There are some installations on which a net dividend of 25 per cent. per annum is not too great. Such developments are in those regions where the market is temporary, as in mining districts, where it is problematical how long the ores that sustain the industry may persist. Under such conditions, a water-power development is, in all respects, equivalent to a mining proposition and should be allowed to retain profit commensurate with the risk. On the other hand, there are developments in which the market is steady and permanent, in which the structures are simple and stable, involving little expenditure for upkeep and only a small percentage for renewals. In developments of such kind a net return of 5 or 6 per cent. may be equitable. Again, the distance intervening between the power site and the market is a most important feature. The line losses, which amount to a high percentage in a transmission of 100 to 200 miles, should be taken account of in the establishment of a

legal rate schedule. Laws regulating the selling price of power should take into account this fact, and a rebate factor should be provided. Such a factor is provided in the Italian law in the assessment of rentals. For power transmitted by means of electricity to greater distances than 10 kilometers, there is granted on the annual rental of 3 francs per horse-power year a reduction calculated by multiplying the square of the distance, expressed in kilometers, by a fixed coefficient of .001. This formula embodies a principle of reduction adopted by the Congress of Electricians at Turin. The minimum charge is .5 franc. It is attained in a transmission of about 31 miles, beyond which no reduction is made. The equivalent in English measure for the above formula is the square of the distance, in miles, multiplied by .00038.

In addition to all of this, it is necessary to establish clearly just what is meant by capital. Too many well-meaning persons believe it is represented by the cost of the plant and that alone. I do not need to remind this audience how grievously mistaken such an idea is. But it is easy for the agitator to convince the public that, because a plant cost a million dollars and its net earnings are one hundred thousand dollars, the income must, therefore, be 10 per cent.

It will be of interest to review some European legislation. The economic problems with respect to hydraulic development are more intensified in Europe than in this country. All the conditions relative to property rights and the utilization of public utilities are more acute. We, in this country, may expect to encounter the same conditions when our country becomes as thickly settled and our individual interests become common interests to the extent that they have in European countries. While we may not find it necessary to adopt European laws and regulations in detail, it will be wise in the adjustment of our own problems to ascertain what these older countries have found it necessary to do. We will consider first the condition in Switzerland, a water-power country of the first rank.

Previous to October 25, 1908, each of the twenty-five cantons of Switzerland had jurisdiction over the waters within its boundaries, and the cantonal authorities regulated their water powers in accordance with diverse principles. It will not be possible here

to examine them all, and we will, therefore, consider a typical case, namely, the Canton of Berne.

Public ownership is common. Berne has made the practice of granting concessions for water-power development to groups of communities. The public policy there is well interpreted in a statement of the director of public works made in October, 1891, and ratified by the Grand Council of the canton, as follows:

"We consider that it is the communities on whom the law imposes the obligation of establishing and maintaining dikes and dams and who, for years and for centuries, have had to bear the expense of maintaining the banks and protection works, without taking into consideration the great damage to which they are often subject on account of inundations, that should profit by the wealth that lies in the utilization of water powers. They have the first right to obtain concessions, and the undersigned [M. Dinkelmann, Director of Public Works, October, 1891] misses no opportunity to call the attention of the representatives of the commune authorities to this fact. All demands for concessions must be published and the specifications filed in the proper communes. The authorities of the commune can oppose them and can intervene as applicant and thus secure by cheap water power the means of sustaining and improving their industries. It is thus our purpose to have the country itself profit by the water powers located within it."

The advisability of placing control of waters and water powers under federal government was investigated under the direction of the Swiss Federal Council from 1892 to 1894. It was found, at the time, inadvisable to make such a change, but the Federal Council did, nevertheless, recommend to the cantons the incorporation of uniform laws based on the following principles:

1. All water powers shall be considered as of public utility.

2. Compulsory mutualization of all water-power interests along a water course with respect to the utilization of hydraulic energy.

3. The right of the cantonal authorities to investigate the industrial value of proposed enterprises and to base their decisions relative to applications for power sites on the results thereof; also, their right to reserve to their own use or that of an interested commune any power site.

4. In case of damages sustained by the owners of water-power

plants by reason of changes made in the regimen of water courses in the public interest, said owners shall not be entitled to indemnity.

5. The limitation of the term of the concession to a fixed number of years, with clauses of forfeiture in case of non-utilization or of redemption by the canton.

The above procedure of the Federal Council shows clearly that the need was felt at the time for uniformity in administration of water powers within the republic, but that public opinion had not yet united in favor of centralization to a degree sufficient to give the members of the council confidence in supporting so radical a measure. A little more time and a little more difficulty with the prevailing conditions was apparently necessary. It required fourteen years more of thought and experience to convince the people of the Swiss republic that necessity and not legal precedent governs the proper course of procedure with reference to water power. On October 25, 1908, by a popular vote of 292 997 against 52 180 in opposition, an amendment to the Constitution was adopted which provides for the centralization of authority over water powers. The amendment reads approximately as follows:

" The Federal Congress shall have supervision over the development of water powers, shall make provision for the disposition of water-rights concessions, and shall regulate the transmission and distribution of electrical energy, so far as may be necessary to protect the public interest and to provide for the proper development of such resources; all water rights to which the terms of the Federal law do not extend shall be under the jurisdiction of the cantons, which shall dispose of the concessions, regulate the same, and impose taxes and fees for their use, but such regulation, taxes, and fees shall not be so severe as to prevent or inhibit the development of water powers. The national government shall regulate and dispose of concessions for powers located on intercantonal and international boundary streams and shall determine the taxes and fees to be imposed thereon, after hearing has been granted to the cantons interested, but such taxes and fees shall be collected by the cantons. No power located on a stream within the republic shall be transmitted to a foreign country without the consent of the Federal Council. The provisions of Federal law shall apply to water-rights concessions already existing, except in cases specifically exempted therefrom by law."

This step taken by the Swiss people is interesting especially because the public policy had already become fixed with reference to the governmental regulation of water powers. The new legislation merely goes an important step further. Many of the cantonal laws were already excellent in their operation. We would have to take a long step forward to reach the advanced stage of the old Swiss cantonal legislation. Yet, it proved not good enough for the Swiss people.

Let us now consider Italian legislation.

In Italy, bodies of water that are susceptible of serving public purposes are designated as *public waters* and are subject to the control of the sovereign. The organic law of August 10, 1884, regulating the diversion of public waters, provides for their use by concession, which is granted by virtue of the payment of rent. The concession fixes the quantity of water allowed to be diverted, the conditions of the diversion, the rental, and the requisite guarantees in favor of agriculture, industry, and the public health. The concession is granted for thirty years or less, but is renewable in favor of the first concessionaire for new periods of thirty years, unless he, in the opinion of the administration, has attained the purpose for which the concession was granted to him. This is a remarkable provision from all points of view, as it gives to the government authority to refuse, in the interest of the public, a renewal of concession, even though the concessionaire may offer to the government greater inducements than can be secured from any other applicant.

If, during the period of any concession, the regimen of the water course is changed by the government for any public interest, the concessionaire is not entitled to any indemnity for damages occasioned thereby, although he may secure a proportionate reduction in rent or a cancellation of the concession.

The rental is 3 francs, or about 55 cents per horse-power year.

It appears that this organic law was, in the opinion of the people of Italy, not sufficient to properly conserve water powers, and after the publication of several administrative decrees, in each of which the law was more and more liberally construed in favor of the state, a commission was appointed, under a decree of August 16, 1898, for the purpose of reforming the law. There are re-

viewed below some of the important recommendations of this commission.

No application is considered unless preceded by examination by a permanent special commission, which determines whether, irrespective of the application in hand, there is legitimate public interest or any present or future need of the state that interferes with the granting of any concession. If, in the interest of the public service, the state finds it desirable to utilize or reserve any water power in any manner, public utility is declared by decree, and all individual applications that cannot technically coexist with the government project are denied.

Another provision intended to reduce the chances for speculation provides that the concessionaire of a public water diversion must remain in connection with it up to the time of the organization of the company, and forbids, under penalty of forfeiture, the transfer to a third party of a concession for the diversion of public waters in any manner before such concession shall have been entirely utilized.

Still another provision gives the state the right to intervene in the case of all concessions in which the maximum use of the power is not made. If the concessionaire neglects or refuses to develop his power to the maximum usefulness, the concession may be turned over to a third party who agrees to make the necessary improvements and the first concessionaire is protected merely by compensation in kind. It is obvious that this provision prevents any concessionaire from manipulating the market by depressing the productivity of any property.

Rebate on rental according to the distance of transmission is provided in this law, as has already been explained.

The law provides that the concession when granted shall be free from all claims in contest. All needful public hearings are provided before granting the concession and it is assumed that any party having a claim that contests an application for concession will present the same at the designated time. If, notwithstanding such presentation, the concession is granted, the concessionaire is secure against all future interference suits. Such a provision is of inestimable value to the promoters of any power scheme. It provides a sovereign guarantee. Many power com-

panies in this country, which have defended costly and malicious suits, some of which may with propriety be termed blackmail, would be glad to avail themselves of such a provision.

We will now consider legislation in France.

The water-power problems in this country have developed an illuminating discussion, and the literature on the subject is copious. The problem in France is somewhat similar, though in no wise as serious as in this country. The French people are fully awake to the situation and have accomplished much, while we are in the initial stages of being aroused.

The laws distinguish between navigable and non-navigable water courses. The former are a part of the public domain and the owners of adjoining property have no rights in the water. The federal government grants concessions for water-power development where and when it believes wise, but such concessions, like all others granted over the public domain, are precarious and can be revoked without indemnity. The water in non-navigable courses is not domain, and, while the ownership of adjoining lands extends to midstream, the bank owners have merely the usufruct of the water, subject to the rights of other riparian owners, under a government permit.

The measure designed to regulate water powers on the public domain which seems to have the most general support is one reported on to the Chamber of Deputies by a special commission in the session of 1908. It provides that power plants shall be classified as " authorized plants " and " plants under concession." Authorized plants are defined as those which develop a gross energy at low water of not more than 200 *poncelets*,* while power plants under concession include all which have a greater capacity. The authorized power plants are governed by laws and regulations now in force, but they are subject to cancellation and are not granted for a period greater than fifty years. The surplus power of any authorized plant may, under exceptional conditions, be sold to the public under regulations promulgated by the commissioner of public works.

Power plants under concession are limited to a specified term, while those developing a horse power greater than the equivalent

* A *poncelet* equals 1.33 horse power.

of 15 000 *poncelets* cannot be concessioned except by special enactment in Parliament. The Articles of Concession specify: *first*, the location of the plant; *second*, the duration of concession; *third*, the character of the appurtenant works; *fourth*, the amount of water to be used, together with provisions that safeguard navigation and public health, domestic water supply and irrigation, provide protection against floods, and preserve the beauty of the landscape; *fifth*, the amount of rental to be paid; *sixth*, the sureties; *seventh*, the maximum charges for sale of power to the public; *eighth*, the amount of power to be reserved for the benefit of the public services, and the conditions under which the same shall be placed at public disposal; *ninth*, the purpose of state control; *tenth*, the conditions under which the right of redemption shall be exercised by the government; and, *eleventh*, the rights and duties of the concessionaire in general, both during the concession period and at its expiration.

The law further provides that all the power-plant appurtenances, including real property and rights of way, shall become a part of the public domain. At the expiration of any concession the state shall immediately take possession of the power plant without liability for indemnity. It is further provided that all power plants which have, in whole or in part, been declared of public utility, and those under concession which do not have for their principal purpose the sale of power, may at all times dispose of excess power not utilized in the regular operation of the plant under conditions fixed by the state council.

Another law governing the development of powers on non-navigable streams was favorably reported on to the Chamber of Deputies in the session of 1908 by a special commission appointed to consider the whole matter. It has already been cited that, although the owners of banks along any non-navigable stream are entitled, under the organic law, to the usufruct of water therein, no power can be developed without a permit from the government. This, of course, is an apparent contradiction in the system of jurisprudence, but it may be explained by the significance of the term " permit " as opposed to that of the concession. The water-power promoter who receives a concession from the French government is vested with rights and privileges that he has not

hitherto possessed. The permit, on the other hand, is merely an authorization. It recognizes the state as the guardian of all public and private interests, and the act of authorization consists in the removal of certain obstacles in the way of private activity. This permits the exercise of a right that existed in substance previous to the application for the permit. Under the system of authorization the proprietor of both banks of a stream is never refused the right to develop the water power. The practical effect of the authorization system is that he is denied the right of not using it. The facts are that water powers on non-navigable streams may be found to be of public utility and, while the private citizen is freely allowed to realize a profit from his possessions, it is conceded that, from the standpoint of the common good, he ought to prove the general utility of his enterprise and satisfy the government that its development along the lines laid down by him will not interfere with larger developments for public utility. In other words, the provision has the purpose of conserving the water power, which is merely another way of insuring that it shall be used to the maximum public benefit.

Now, the law above cited does not propose a change in the obligation to secure an administrative permit, but it defines the power of the government with reference thereto more specifically. It provides that the petitioner must indicate the location of the works and the use to be made thereof, must prove that he possesses the lands necessary, which must be at least one third of the total length of the banks in the section under consideration. The application is subject to examination, and it is decreed by the Council of State whether the request shall be granted or denied. The permit is barred by limitation if the work is not executed within three years after the permit is issued, and the permit may always be withdrawn by decree of the Council of State if the conditions prescribed in the issuance thereof for the protection of public interest have not been complied with. The permit specifies the precautions that must be taken for the protection of the general public, especially concerning public health, floods, domestic water supplies, irrigation, and fisheries. During the first ten years immediately succeeding the beginning of operation of the plant, any public authority may requisition the site for the public

service, with suitable indemnity, or any public authority may requisition a part of the product of the plant. Hydraulic plants may be established by third parties on private property by virtue of a declaration of public utility, upon payment of a proper indemnity to the owner of the rights, whether or not said owner agrees. The only condition is that of public utility and, when such utility is declared, the power plant, together with appurtenant realty and equipment, becomes a part of the public domain. All of this legislation insures the development and utilization of water powers in accordance with their maximum public usefulness and prevents the holder of the property from exercising his rights to the detriment of public interest.

Opportunity is not here afforded to review the measures adopted by other countries, and it will be appreciated that the writer has not had an opportunity to discuss or analyze in any worthy way the principles upon which power legislation is justified. It is believed that enough has been said to indicate what is the attitude of at least three European countries. It would be interesting to review such legislation in the United States, but that is already more or less familiar to many of the members of this association. In only one case, namely, that of the forest service in the administration of water powers on national forests, is there any approach to the regulative authority that has been found to be necessary in the case of European powers.

The water powers of this country have a higher ultimate significance than is generally conceded to them. They are certain to have a dominating effect on the material progress of this republic. In the old world it has been decided that a proper function of government is to declare water powers of public utility and to place them under appropriate laws, the assumption being that the public has a dominant interest in the development of this great natural resource.

No one can safely predict the final form of laws to be enacted to this end. Whether they will lead to government ownership and control, whether in this country the state or national government shall control, are matters for the future to determine. If our present form of government proves to be all-sufficient in this respect, then it will prevail. At least three European countries

have found it necessary to make water power a national matter. This paper is not to be considered as a plea for nationalization. The author does not at present support that view, but he is impressed with the fact that necessity and not legal precedent must eventually direct the course of procedure. It can hardly be expected that when the necessity arrives it will readily be recognized and accepted. Acceptance will be postponed, at enormous cost, until the people can secure a clear vision above the mist of legal precedents. The great difficulty will not be to regulate water-power development and operation, but to convince many persons that a thing may be necessary, even though it involve a change in our habits of thought.

DISCUSSION.

PROF. DUGALD C. JACKSON.* I think that probably all of us may be ranked as conservationists, and consequently we all believe that the water powers should have something done for them. As a matter of fact, this country needs encouragement in the development of water powers rather than discouragement. Many things have been said by talking conservationists which seem to indicate a desire to control water powers in various ways that are not wisely considered and would tend to discourage development; but we need encouragement for the development of water powers, wherever such development is economical and sound, instead of discouragement. It seems to me that properly safeguarded encouragement might be worked out by constructive statesmanship in ways resembling those worked out through the Carey Act and its related enactments for the development of the use of water for irrigation purposes.

There are three sound grounds upon which we need development of water powers. One is to conserve comfort and convenience, another is to conserve other natural resources, and the third is to maintain an industrial eminence. In respect to the former, this country needs a network of power lines throughout its entire area where it is densely populated, whereby any person may be able to get power as we get gas, water, and electric power in the cities. That is coming to pass in a few portions of the

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country. It is coming to pass in the Carolinas, and in certain portions of New York State, for instance; it has come to pass in portions of the European countries, especially the northern part of Italy. The effect upon the development of the country and the ease of life which would arise from this farm-to-farm distribution of power is really inconceivable to those of us who have not experienced its benefits. This extension of power lines will increase the comfort and profit of country life and do much to regenerate interest in farm life as contrasted with city life. If we are to enjoy such advantages, we must encourage the fullest development of our sources of water power in all the well-populated portions of the country.

Now, let us look at the matter for a moment from the standpoint of the conservation of our other natural resources. Our methods of using steam-generated power for industrial purposes are quite uneconomical. I presume that on the average we use in our industrial plants six or seven pounds of coal per horse power developed, and on that basis a horse power developed from an hydraulic plant for ten hours a day, operating for the working days of the year, means a saving of about ten tons of coal in a year; and a million horse power (a figure mentioned by Mr. Leighton) means a tremendous saving from that point of view. I do not mean that the water power will necessarily in every instance supplant fuel-using power where steam plants are now installed, but I mean that it will either supplant fuel-using power now installed, or else it becomes a substitute for fuel-using power which might be installed were the water power not available; each horse power developed from water means an important conserving of fuel, and, consequently, we need all the development of water power which can be made succesfully from an economic standpoint. Encouragement of such development is of the utmost importance.

On the other hand, we do need such control of water-power sites as will keep speculators, who do not themselves intend to develop the powers, from getting control and preventing development by holding the properties at a speculative price. There are, therefore, two things to be avoided: One is government control of a kind which tends to prevent rapid development, —

substituted for that we should have encouragement of development wherever such development is economically sound,— and the other is failure to control the power sites in a way that will prevent speculators from securing water powers and holding them for a future rise in price. There are things to be avoided and, on the other hand, there are things we need; and I believe that only after some more years of threshing out these questions we will come, in this country, to a reasonable and just view of what is right. I think that water power is a public utility, but I do not believe that a man who has an ownership in a waterfall and the land on either side should have his property seized by the government or absolutely controlled by the government. I do believe that wherever practicable he should be encouraged to put that waterfall into use for economic service.

PROF. GEORGE F. SWAIN.* I fully believe that the time has come for this question of the regulation of water powers in this country to be taken up and acted upon by the American people. I believe that legislation is coming. Of course, that legislation should have, as Professor Jackson has said, these two objects in view: To regulate and to protect the rights of the public on the one hand, without repressing development on the other. In our western country development is the thing that is needed, but in the present state of the public mind in this country I think that, perhaps, too much attention is paid to protecting the rights of the public at the expense of those who would like to develop our resources.

I have been especially interested in Mr. Leighton's remarks with reference to a 25 per cent. dividend in some cases not being too great. That leads me to suggest that any legislation on this subject will involve a good many points which will have to be covered in a broad way only, and not specifically. A great deal of discretion will have to be left, in any case, to those who administer the law, and it will, therefore, be of great importance that such law should be administered by persons who hold their positions not temporarily, but for considerable periods of time, — persons who are familiar with the subject and who are determined to administer the law in a liberal and broad-minded spirit.

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In regard to practice in foreign countries, I think such practice should be considered more with reference to its general aspects than its specific provisions. The latter are no safe guide to us, because the local conditions are very different, but the general tendencies may be worthy of imitation.

PROF. DWIGHT PORTER.* I have been a little curious, in hearing of these apparently wise provisions which have been adopted in foreign countries, as to how they have actually worked out in practice. They are in part designed to protect the public, and I wonder whether Mr. Leighton is informed as to what the experience has been with them. Have they really given this protection, and have they been carried out with freedom from friction and to the general satisfaction of the people?

MR. LEIGHTON. Of course, Mr. President, all these laws have been discussed, antagonized, and supported abroad, just as they are in every live country. In some cases they have not been laws for a sufficient length of time to test them practically, but in the case of Switzerland and in the case of Italy they certainly have been a great success. The laws have been wisely administered, and they have actually encouraged the development of water power.

All the laws of those countries are not acting against the water-power people. Some of them are in actual encouragement of the water-power people as against the public as a whole, you might say. For example, under a concession in Italy a man who gets a water-power concession is absolutely protected by government title. He does not have to submit to the malicious suits such as are common in this country. I know of a great many water-power companies that would be glad to incorporate under the laws of Italy, simply for the protection that they would get.

On the whole, I am quite ready to state that these laws have done all that they were expected to do, and more. Indeed, the very fact that more stringent laws which increase the scope of government control are continually being agitated and frequently enacted is an index of the practical effect of the restrictions and the methods of the use of water power as regulated and developed.

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THE PURCHASE OF COAL ON AN EFFICIENCY BASIS.

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Conservation of the national resources is a subject which is attracting much attention at the present time, and as coal is one of the most important of these resources, and one which cannot be replaced when the supply is exhausted, it is very desirable that efforts to prevent waste both in mining and using coal should be encouraged. Any improvement in methods or apparatus tending to increased efficiency in the use of fuel not only benefits the individual consumer who adopts these improvements, but also assists in the conservation of this most important resource.

The development of the modern high-duty steam engine, in the larger units, has now reached a point where but little increase in economy can be expected from further improvements. Attention, therefore, has been transferred to the steam generator, the boiler and furnace, and it is through improvement in design and operation of the boiler-room equipment, and in the purchase and burning of coal, that the greatest increase in efficiency may be expected.

Until quite recently coal was purchased with but little regard to its heating value, the common practice being to use the trade name when ordering, as Georges Creek, Pocahontas, New River, etc.

The difficulty with this method was that even if the dealer furnished the kind of coal called for, there was no guarantee that the coal would be of uniform quality. Such names refer to mining districts, which contain many mines, the output from which shows great variation, due both to the different quality of coal in the various mines and to the degree of care used in preparing the product for market.

Even if the coal is specified to come from a particular mine, there will still be some variation in quality, and there will be the additional disadvantage that through strikes or accidents the supply from this mine may suddenly be cut off.

The greatest disadvantage, however, of the old method of purchasing coal is that in case of variation in the quality supplied there is no definite basis of settlement between the dealer and consumer. This works to the disadvantage of both parties, as sometimes, when the dealer supplies a good coal, trouble is caused by the firemen being unaccustomed to firing this particular kind, or by the boiler plant being unfitted to burn the coal efficiently, or by the general tendency to blame the coal for any falling off in economy which is observed in the operation of the plant. On the other hand, the dealer may deliver coal far below the standard and claim that it must be good because the same kind of coal is giving other customers good satisfaction, and that the trouble must be in the customer's fire-room.

Without chemical analysis or calorimeter tests, it is very difficult to prove that the coal is bad, or at least to convince the dealer of the fact. And, moreover, even if the case is proved, there is no basis of adjustment. The result is, in most cases, that the coal must be used and paid for at the full contract price, often to the serious financial loss of the consumer if the amount of poor coal is large.

The dealers were at first much opposed to specifications based on heating value. This opposition was due in part to conservatism, as it is exceedingly hard to change trade customs and methods, and in part to unwise and unduly severe requirements in some of the earlier specifications. Now, however, the more progressive coal operators and dealers favor such a method, as it furnishes a definite basis of agreement covering variation in quality, terms of settlement, etc., and provides, by means of premium and penalty clauses, an incentive to furnish a superior quality of coal. The honest dealer is also protected from unfair competition, as it was a common occurrence, when proposals were requested for furnishing a particular kind of coal specified by name, for unscrupulous concerns to bid a low price with the intention of furnishing a cheaper grade of coal if they secured the contract. This course would not be profitable in case of a contract made on a heat unit basis, as the inferior coal would either be paid for at a low price or rejected.

In drawing up specifications it is of the utmost importance that

the interests of both the dealer and consumer shall be thoroughly protected and that the requirements shall be made as simple and plain as is consistent with securing the desired result.

The most economical coal to buy is the one that will make steam for the least cost, all things considered. This does not mean necessarily the cheapest coal, or even the coal which will evaporate water at the least cost considering the price of coal alone.

The first step, therefore, in formulating specifications is to find out what kind of coal will give the best results in the particular plant where it is to be used, and to make such requirements as will insure the delivery of the desired quality.

The principal points which should be covered by the specifications are as follows: The total amount of coal desired; the rate of delivery; the approximate proportions of lump and fine coal; a statement of the approximate composition of the coal desired, including the percentages of ash, sulphur, and volatile matter; the heat units per pound desired, and the maximum limits of ash, moisture, sulphur, and volatile matter which will be accepted. The method of determining the amount to be paid for, whether by bill of lading or by delivery weights, the method of taking samples, for conducting tests, for making corrections in contract price for quality, should be stated and there should be a clearly defined provision for settlement of differences which may arise between dealer and consumer.

Provision should also be made for purchasing a limited amount of coal from other dealers for test purposes if so desired, for procedure in case the contractor fails to deliver coal when requested, and for increasing or diminishing the contract amount by a certain percentage if conditions of operation make such a course advisable.

It may be of interest to point out some of the considerations which ordinarily govern a purchaser in selecting the proper kind of fuel, and to show the effect of the impurities and other constituents of the coal.

The location of the plant is an important matter, for it determines the freight rate and cost of whatever teaming may be necessary. As the transportation charges are generally the same per ton for all grades of coal, it follows that the larger the proportion

this expense is of the total cost of the coal, the more advantageous it is to use the higher grades of fuel. It is important to select a kind of coal which will not be subject to annoying and expensive interruptions in delivery.

If transportation rates are such that the purchase of lower grade coal would apparently be profitable, the plant equipment and conditions of operation should be carefully considered to see if there is sufficient boiler capacity when burning fuel of low heating value, and if the grate and draft conditions are suitable. If the plant is not suitably arranged, a study should be made to determine if the probable saving resulting from using the low grade coal will warrant the expense of any changes in equipment which may be necessary. A study of the labor conditions is also important, as the poorer the quality of the coal, the greater the amount that has to be handled, resulting in an increase in the work of keeping the fires in order and of removing the ashes.

The size of coal is also of considerable importance, uniformity of size as a rule giving the best results. Some of the best steam coal is of a very friable nature and, if subjected to several handlings before reaching the consumers' bins, it may be delivered in a powdered condition. Coal in this form has a tendency to clog the air passages in the fuel bed, causing imperfect combustion, and to fall through the grate into the ash pit, thereby increasing the waste. The effect of fine coal is particularly bad when the smaller sizes of anthracite are used with it. On the other hand, some semi-anthracite coal is exceeding hard and is delivered in large lumps, which break the coal-handling equipment and cause extra labor in the fire-room, as the lumps have to be broken up with a heavy hammer before they can be burned.

The amount and composition of the ash has much to do with the value of a coal, for freight and handling charges must be paid on the incombustible material and, in many cases, the ashes have to be carted away at considerable expense.

A coal with a large percentage of ash clogs the fire, thus checking the draft and causing incomplete combustion and requiring more frequent cleaning of the fires, which causes a waste of coal, as a considerable amount of combustible material is carried into the ashpit with the clinkers. In such a case, moreover, the fire doors

have to be opened more frequently, thus cooling off the gases and causing unequal expansion in the boiler plates, and the ash is heated to the furnace temperature and much of this heat is wasted. The fusible constituents of such a coal form clinkers, which increase the labor of firing and interfere with proper combustion. The percentage of ash may be considerably reduced by careful preparation at the mine.

There is some moisture, generally about one per cent., in the coal when mined, and as coal is transported in open cars, the amount of moisture may be either diminished or increased according to weather conditions prevailing during the time the coal is exposed in the cars. Ordinary bituminous coal will hold about five per cent. of moisture without dripping. This water is, of course, worse than useless to the consumer, as he has to pay all charges on it, and in addition loses the heat required to evaporate it and superheat the steam in the furnace. Coal containing a large amount of moisture, if delivered in cold weather, is exceedingly hard to unload, as the contents of the cars are frozen into a solid mass requiring hard labor with the pick to break.

Sulphur generally occurs in coal as iron pyrites or sulphide of iron, and sometimes in cubical crystals resembling brass, or in combination with lime as sulphate of calcium or gypsum. It also sometimes occurs in a free state.

While sulphur is combustible, its heating value is less than one third that of carbon. A considerable amount of the sulphur in coal does not burn, but remains in combination with the other constituents of the ash, causing the worst kind of clinkers, particularly if the coal is high in sulphur and iron with a small percentage of ash, when it forms a tough slag, which is almost impossible to break up, and which in some cases unites with the cast-iron grate bars and quickly ruins them. The sulphur which is burned forms a gas which in the presence of moisture generates an acid, which quickly corrodes the iron work of flues and stacks, while the ashes and clinkers which gather on metal surfaces also have a powerful corrosive action if they become moist.

It was formerly thought that sulphur was the cause of the so-called spontaneous combustion of coal, but, although it is a fact that coals containing a high percentage of sulphur often give

trouble from heating, there are coals which contain but a small amount of sulphur which heat badly; and the amount of sulphur in coal is far too small to account for the rise in temperature of the pile, even if it were all oxidized, which is never the case. While the cause of heating is not fully understood, it appears to be due to the structure and mechanical condition of the coal rather than to its chemical composition. Some coals seem to have the property of absorbing oxygen, with consequent rise in temperature, and as the heat increases, the affinity for oxygen seems to increase until, under favorable circumstances, the coal becomes ignited.

Finely divided, freshly mined coal having a considerable amount of volatile material and moisture and stored in large masses is apt to heat. As a rule, the heating is not uniform throughout the mass, but starts at certain points in the pile where favorable conditions exist, such as near partitions or around pillars, where a supply of oxygen may be had without sufficient radiation to remove the heat as fast as formed. The small ventilating pipes which are sometimes installed with a view to preventing heating furnish ideal spots for starting fires.

The effect of volatile matter in coal depends largely on the type of furnace and boiler in which it is to be used, as with proper equipment coal containing very large percentages of volatile matter may be burned with economy and practically without smoke. With the ordinary steam plant, however, coal having a volatile content below 22 per cent. will prove more efficient and give less trouble on account of smoke.

The combustible volatile matter consists principally of hydrocarbons, methane or marsh gas (CH_4) being the most important. Ethylene (olefiant gas) (C_2H_4) is also a constituent. A considerable proportion of the volatile matter is non-combustible, consisting of water of composition which is not driven off at the temperature of the drying oven. The inert matter varies from about 4 per cent. of the total weight in eastern coals to 14 per cent. in western coals. There is also from 1 per cent. to 1½ per cent. of nitrogen and small quantities of carbonic acid (CO_2). The combustible portion of the volatile matter has a high heating value, owing to the hydrocarbons. Methane has a calorific capacity of 23 600, while carbon has 14 544 and sulphur 4 050

B.t.u.* per pound. Consequently, a high volatile coal will often give a high result when tested in the calorimeter, but when burned in the furnace the evaporation results may be disappointing unless the equipment is suitable. The volatile matter distills off rapidly from the green coal, tending to lower the furnace temperature below the ignition point; it is also difficult to get the gases mixed with the proper proportion of highly heated air and provide space enough for them to be completely burned before coming into contact with the water-heating surfaces of the boiler. For this reason it is important to limit the percentage of volatile matter to an amount which will give satisfaction in the particular plant where the coal is to be used.

TESTS.

The most important part of the testing operation is obtaining a sample which shall represent as nearly as possible the true average quality of the lot of coal to be tested. This is best accomplished by taking small portions from all parts of the shipment to be sampled, being careful to preserve the same proportions of lumps and fine in the sample as in the lot from which it is taken. The amount of the sample thus taken should be governed somewhat by the size of the shipment to be tested, but it should not be less than a bushel in any case.

The sample should be spread out on a clean, hard surface — an iron plate is best, but a clean floor will do — and the large lumps broken with a hammer. After the coal is thoroughly mixed, the pile should be flattened out in circular form and divided into quarters by drawing diameters at right angles. The opposite quarters should be rejected, and the operation repeated, breaking the lumps finer each time, until about a quart remains. This is the sample to be tested, and it should be sent to the testing laboratory in an air-tight metal or glass receptacle. All the operations described should be carried out as rapidly as possible to avoid loss of moisture.

It was formerly the custom to make a complete analysis of the coal, including moisture, ash, total carbon, hydrogen, oxygen,

* British thermal unit, the amount of heat required to raise the temperature of one pound of water 1° F.

nitrogen, and sulphur. This is often called ultimate analysis. The heating effect may be calculated by the Dulong formula,

$$\text{B.t.u.} = 14\,600\,C + 62\,000\,(H - \tfrac{1}{8}O) + 4\,050\,S,$$

in which B.t.u. represents the heat derived from the combustion of one pound of the coal, C, H, O, and S being the percentages, expressed as decimals, of carbon, hydrogen, oxygen, and sulphur found by analysis. The term $H - \frac{1}{8}O$ is used in accordance with Dulong's theory that the oxygen present in the coal with sufficient hydrogen to combine with it and form water should be considered inert. One pound of oxygen requires one eighth of a pound of hydrogen to form the combination.

At the present time the practice is to make an approximate analysis, which includes the determination of moisture, ash, volatile matter, and sometimes sulphur. The calorific value is obtained by burning a small portion of the powdered sample in a calorimeter.

There are several types of this apparatus in use, but the bomb calorimeter gives the most accurate results and is now used in the best laboratories. This instrument consists of a very strongly constructed steel or bronze shell, fitted with a screw cap, or, if in a spherical form, with a screw joint in the middle. The interior surface is lined with porcelain, nickel, or platinum, or sometimes with a heavy gold plate, the object being to produce a surface that will resist the corrosive action of the acids generated by the combustion.

A carefully weighed amount of finely powdered coal is placed in a small platinum pan suspended in the interior of the bomb, a platinum fuse wire is arranged to ignite the charge, and the bomb is then filled with oxygen gas under a pressure of three hundred pounds per square inch and placed in a vessel containing a weighed amount of water, the bomb being completely submerged. After the temperature of the water has been equalized by means of a stirring device, the coal is ignited by sending an electric current through the fuse wire. The heat derived from the combustion is absorbed by the water, the metallic parts of the bomb, the stirrer, and the jacket. The rise of temperature of the water is observed by means of a carefully calibrated thermometer, and from this

reading, corrected for the heat absorbed by the metal parts of the bomb, and for radiation, the heating effect of the coal is calculated. In order to obtain accurate results the greatest care must be used in every part of the operation, and the thermometer must be extremely accurate and should be read to thousandths of a degree; it is best to use a thermometer which has been tested at the United States Bureau of Standards in Washington.

The amount of ash is determined by burning an accurately weighed portion of the coal in a platinum crucible over a Bunsen burner until all trace of carbon has disappeared; the ash is then cooled, weighed, and the percentage calculated.

The volatile matter is determined by heating a weighed amount of the dry, powdered coal over a Bunsen burner flame of standard height for a fixed time, usually seven minutes; the loss of weight is considered to be the amount of volatile matter.

Moisture is estimated by drying the sample at a temperature of 105° C., equivalent to 221° F., for one hour in an oven fitted with a heat regulator. Sometimes a large sample of the coal is spread out in a shallow pan and allowed to dry for twenty-four hours at the ordinary temperature; the coal is then said to be air dried. The remainder of the moisture is then determined on a small sample by drying in an oven as previously described.

Sulphur is determined by Eschka's method, which consists in heating the coal with magnesium oxide, sodium carbonate, and ammonium nitrate in a platinum dish, using an alcohol flame to avoid the sulphur in ordinary illuminating gas, dissolving the resulting mass in dilute hydrochloric acid, filtering and determining the sulphuric acid in the filtrate with barium chloride.

Fixed carbon is calculated by subtracting the percentages of ash, moisture, volatile matter, and sulphur from 100.

The practical test made by burning the coal in the boiler furnace is advocated by many engineers as the only satisfactory way to test coal, and it has some advantages if enough coal is available to make a test of sufficient duration.

The actual evaporation under working conditions, the character and amount of ash and clinkers, the tendency to smoke, and other valuable information may be obtained from this test. Comparatively few plants, however, are equipped with the facilities to make

satisfactory boiler tests, and it is very difficult in any case to make these tests, using different kinds of coal, under conditions which are strictly comparable. It often takes some time for the fireman to learn how to burn a coal with which he is not familiar in a way to get the best results, and sometimes he is prejudiced and does not give the coal a fair test.

The best practice is to make an approximate analysis and a calorimeter test of the coal, supplemented by a practical test under the boiler, using a sufficiently large amount of coal for a run of at least forty-eight hours' duration, noting carefully the amount of water evaporated per pound of coal, the character and amount of ash, and quantity and color of the smoke.

Where a considerable number of coals are offered in competition, it is generally possible to eliminate all but two or three from consideration by means of the approximate analysis, calorimeter test, and price. By making a practical test of the remaining coals under working conditions one should be able to choose the coal which will be the most satisfactory, all things considered.

But little consideration should be paid to small samples furnished by dealers, or to reports of analysis published by them, as it is quite easy to select a small sample of good coal from a pretty poor lot and to get a chemist's report on it which will be very misleading in regard to the average quality of the coal in question.

The better way is to take a sample either personally or by an experienced representative from some lot or cargo of the coal under investigation and use this in making the tests.

SPECIFICATIONS.

The United States government in buying coal for the federal buildings uses a specification based on the heating value of the coal as delivered at the place where it is to be used. In order to establish a standard for comparison of bids and for payment if the proposal is accepted, the bidder is required to state the price per ton, the B.t.u., and the amount of ash in the dry coal which he proposes to furnish.

The price named in the proposal is increased or decreased on a percentage basis for variation in quality above and below the standard set by the dealer. For example, if the calorimeter tests

show that the heating capacity in B.t.u. of the coal is 2 per cent. more or less than the established standard, the price will be increased or decreased 2 per cent. The price is further corrected for ash by payment of a premium of one cent per ton for each whole per cent. of ash less than the standard established by the dealer, and if the ash is 2 per cent. more than the standard a deduction is made, varying from 2 cents to 18 cents per ton, according to a schedule, with an increasing penalty rate as the percentage of ash increases. There is a fixed maximum of ash, volatile matter, sulphur, and proportion of fine dust. If these limits are exceeded, the coal is subject to rejection. These maximum percentages vary in different sections of the country in order to conform to the composition of the coal which may be obtained in the local market.

The Commercial Testing and Engineering Company of Chicago have a standard form of specification which is used by their clients.

A contract grade is established by the dealer, who states the percentage of moisture in the coal as delivered, the percentage of ash in the dry coal, and the B.t.u. per pound of dry coal. From these data a *contract guarantee* called the *net B.t.u. for one cent* is computed by multiplying the number of B.t.u. per pound of dry coal by the percentage of moisture expressed in decimals, subtracting the product so found from the number of B.t.u. per pound of dry coal, multiplying the remainder by 2 000, and dividing the product by the rate per ton, expressed as cents, plus one half of the ash percentage expressed as cents.

Samples of the coal as delivered are taken by the consumer and are forwarded to the engineering company for analysis. The payments are made on a basis of delivered values, obtained by dividing the number of B.t.u. in a ton of 2 000 pounds of moist coal by the *contract guarantee* and subtracting from the quotient expressed as dollars and cents one half of the dry ash percentage delivered, also expressed as cents.

Coal containing 3 per cent. more ash, 5 per cent. more moisture, and 500 fewer B.t.u. per pound of dry coal than specified in the contract grade may be accepted; beyond these limits the coal is subject to rejection. The dealer is also required to state, for the coal he proposes to furnish, the percentage of fines or dust passing a

screen having circular perforations ¼ inch in diameter, and if this standard is exceeded by 5 per cent. in the coal as delivered, the excess per cent. above that amount allowed is penalized in proportion to the cost of the coal and the estimated damage caused by the fine material by choking the draft, etc.

This specification is intended to keep the cost of evaporating 1 000 pounds of water a constant in any given plant in spite of normal variations in the quality of the coal, and it is said to have accomplished this purpose very satisfactorily in the purchase of more than a million tons of coal, including most of the well-known varieties used in the eastern and central states.

The principle according to which deductions are made is that, in order to hold in court, the penalty exacted for inferior quality must only offset the damage sustained and must not constitute a source of profit to the consumer. It is also considered that the calorific value of the combustible portion of the coal from any given mine is a constant and that the correction for 1 per cent. of ash varies in different coals from 150 to 200 B.t.u. per pound.

In another form of specification the purchaser fixes an approximate analysis and a standard of heat units, allowing premiums and deductions at a fixed rate, generally 1 to 1½ cents per ton for each 50 B.t.u. per pound determined by calorimeter test above or below this standard of heating value. This rate should be proportionate to the cost of the heat units determined by the contract standard and the price per ton bid. Ash above a certain percentage, generally 8 or 9 per cent., is penalized, generally at the rate of 1 cent per ton for each ½ per cent. or fraction thereof in the dry coal in excess of the maximum allowed without deduction.

The approximate analysis for the better grades of steam coal sold in New England should be about as follows:

	Per Cent.		Per Cent.
Ash	5 to 9	Sulphur	0.6 to 2
Moisture	1 to 4	B.t.u. in dry coal	14 200 to 15 000
Volatile	16 to 23		

When the coal is paid for on delivery weights. the B.t.u. in the coal as received forms an equitable basis of settlement, as it corrects for moisture.

Where the bill of lading weights govern settlements, the average

moisture of coal in the mine or on cars at the weighing point, if this can be ascertained, may be used as a constant, but if the contract covers an entire year's delivery, as the variations in moisture in the coal as received will probably balance very nearly, no injustice would be done to either party if adjustment for quality were made on the *as received* basis.

Sometimes the dry coal basis is used in making corrections for heating value and the moisture is allowed for separately by subtracting from the weight of coal paid for the excess above a fixed maximum.

In most cases it is best to let the dealer establish a standard of quality for the coal which he proposes to furnish, but where several plants under the same management and at considerable distances apart are to be supplied with coal under the same specification by different dealers, who may be unable to supply the same kind of coal at all times, the problem becomes more complicated and it will probably cause less confusion if the consumer sets the standard, provided it is established with good judgment after having carefully considered all the circumstances of the case.

A committee of sixty-seven members of the American Society for Testing Materials has been appointed and now has under consideration the subject of coal specification with the object of standardizing as far as is practicable the requirements for different classes of coal. This committee has made a progress report, in which certain reforms regarded as desirable are outlined as follows:

(1) "A classsification of coals with respect to fuel efficiency, the adaptation of equipment to coals for obtaining the greatest efficiency from each class of these fuels, the continued use at each plant of that type of fuel best adapted to the equipment, the use of low-grade fuels either at the mine or within short distances and the use of the high-grade fuels under conditions demanding highest efficiency and requiring distant transportation."

(2) "Special efforts on the part of architects and engineers to provide everywhere adequate space for power and heating plants and proper equipment with a view to making the most efficient use of the fuels that are most available."

(3) "Such readjustment in the prices at the mines of the different classes of coal as will render possible clean and safe mining, and the use at local or distant points of all grades of coal worthy of being placed on the fuel list."

W. W. Polakov, in an article in the *Engineering Magazine*, has divided into stages all the operations from purchasing the coal to the final result of useful work done by the engine, giving to each stage a calculated efficiency.

For a typical case of a pumping engine he gives the following figures:

Stage.	Efficiency. Per Cent.
Purchasing coal	67.77
Combustion of coal on grates	90.10
Utilization of heat for generating steam	86.28
Utilization of steam in engine	82.20
Utilization of mechanical energy of the engine for pumping	89.11
Resultant total efficiency	38.59

The first three steps may be used to compare different coals, the efficiency of the steps being determined in the following manner:

First. The efficiency of payment. Obtained by comparing the actual cost of 1 000 000 B.t.u. in the coal under consideration with a standard price for which the same quantity of heat units could be purchased in the same market. In estimating the price, the cost of additional freight, handling, removal of ashes, etc., consequent upon the average percentage of ash in the coal it is proposed to purchase should be taken into account.

Second. Efficiency of combustion, which is the combustible actually used divided by the combustible available. This is determined by a boiler test, taking account of the amount of combustible in the refuse from the ash pit.

Third. Efficiency of utilization of the products of combustion. Found by dividing the heat absorbed per pound of combustible by the thermal value of one pound of combustible. This also requires a boiler test and calorimeter determination of the heating power of the coal.

The total efficiency is found by the formula $E_t = \frac{E_1 \times E_2 \times E_3}{10\,000}$,

in which E_1, E_2, E_3 respectively represent the efficiency of the three stages.

While this method may be useful in comparing coals, it is not suitable for determining the value of coal as delivered in regular operation.

The foregoing specifications and tests apply to semi-bituminous and bituminous steaming coals. Anthracite coal is commonly purchased under a much simpler specification based on the percentage of ash alone, or sometimes on ash, moisture, and sulphur, with an allowable maximum for each, and penalties and premiums based on the price per ton.

It is probably impracticable to buy the buckwheat sizes of anthracite under a penalty and premium specification, for the price of these coals at the mine is low and the margin of profit is so small that it is entirely wiped out by even a small deduction from the selling price. The dealer to make himself safe will, therefore, bid so high a price that the use of such coal offers no advantage to the consumer.

It is unfortunate that there is at present so much confusion in regard to specifications, and it is to be hoped that the committee of the American Society for Testing Materials will be able to devise requirements which will result in uniformity of specifications for the different classes of coal as far as is practicable. Such a standardization is greatly to be desired, as there is no doubt that this method of purchasing coal has decided advantages to both parties, if the contract is properly made, and that it also has a marked tendency to raise the quality of coal offered for sale.

DISCUSSION.

MR. HARRY L. THOMAS.* Would it be reasonable to expect to obtain a uniform grade of anthracite coal by continually buying from the same mine? For instance; if a carload of coal proved to be well suited to the needs of a gas producer, would there be any reasonable chance of getting the same grade by telling the dealer that we wanted more from the same mine?

MR. DOANE. I should say you would stand more chance that way than any other, but you could not be absolutely sure. If the dealer had any way of making sure that he did get coal from the same mine, I should think you would be fairly sure of getting the

* Assistant Superintendent Water Works, Hingham, Mass.

same quality of coal, but the way the dealers are fixed around here, it does not seem to be practicable to do that. We find, even when dealing with the largest dealers, that we get quite a large variation in the coal at different times, even when we try as hard as we can to get the same kind.

From our experience I should think it would be very difficult indeed to be sure of getting the same coal. You might get a few carloads which would be practically alike, and then an odd car would come in which would be quite different. Our experience has been, in buying pea and common-size anthracite coal, that it is hard to secure a uniform delivery. It may be, however, we are in a worse fix than you are, if you buy it in carload lots, because the anthracite we buy is generally for a station where the storage capacity is so small that the coal has to be delivered in cartloads.

MR. A. S. NEGUS.* It has been my experience that the quality of coal varies with every different lot that you buy. If you buy a cargo, you are pretty apt to get nearly all one kind, but if you get another cargo you are likely to get something different; it may be a little better or it may be a good deal poorer.

MR. FRANCIS W. DEAN.† I think that Mr. Doane has covered all of the points concerning the quality of coal, method of testing, etc., in a very admirable way. It seemed to me, as I followed his paper, that I should take exception to only one thing, possibly, and that is the method of testing coal by means of boiler tests. Generally speaking, I think that a boiler test is a very unsatisfactory method of determining relative values of boilers or of fuel, chiefly because different firemen can produce such different results with the same boiler and the same fuel. I must admit, however, that this can be done, usually, better at water-works plants than elsewhere, especially with twenty-four-hour service. At such plants there is usually a considerable ambition to produce good results, and the best methods of obtaining those results are studied.

Some years ago, I made some tests of a high-class locomotive type boiler at the Lynn Water Works, with at first very discouraging results. The boiler was put in with a remarkable high guarantee, viz., that it would evaporate 12 pounds of water per pound of

* Pumping Engineer, New Bedford Water Works.
† Mill Engineer and Architect, Boston, Mass.

combustible from and at 212° F. The result obtained on this test, instead of being 12 pounds or more, was 8.34 pounds. After putting in a new grate we obtained 9.54. I then changed firemen, selecting a man whom I knew could produce good results, and obtained on a preliminary trial 12.84 and on the final trial 12.04. After the second trial I had the gases analyzed and it was found that there was considerable carbonic oxide formed and an unusually large amount of carbonic acid, but that there was no free oxygen present. It is probable that hydrocarbons were being distilled from the coal and going up the chimney. This, of course, could not be detected by the ordinary gas-analyzing apparatus.

In regard to a question which one gentleman has asked about getting the same quality of coal in different cargoes, it seems to me that if you consider the fact that coal from the same mine comes from different veins, it is hardly likely that the same quality will be obtained in different cargoes, or perhaps in different parts of the same cargo.

MR. DOANE. I would say in reply to what Mr. Dean has said, that I tried to make it clear in the paper that I did not have a great deal of faith in the boiler test, and that it was simply one element in arriving at a decision. That is, taking into consideration the calorimeter test and the chemical analyses, I said that you could derive certain information from a boiler test, besides the efficiency of the coal in evaporating the water, which was valuable, namely, the amount and kind of clinkers you were liable to get, the character of the ash, whether the coal smoked badly or not, and other information of that nature, all of which are important considerations in settling the question of what coal to buy. I know that what Mr. Dean has said about the boiler test is very true.

MR. DEAN. Different kinds of boilers have to be fired differently. It has come to me to design and test a good many vertical boilers of late years. A vertical boiler is not generally approved of, but I think that is due to want of familiarity, although it is a fact that a vertical boiler has to be fired differently from other boilers. I think that a boiler that has a horizontal flame and an opening through the door, so you can let air through it, is, with careless firing, more apt to give good results than a vertical boiler, because

the air will go where it is needed, mix in, and produce better combustion than it will in the other case. But if the vertical boiler is fired properly, so as to get a proper amount of air in, you will get better economy. I think Mr. Doane has found that it does not make much difference at Chestnut Hill whether they run the Belpaire boiler, the vertical boiler, or the horizontal return tubular; they get about the same duty all the time.

MR. DOANE. I am rather inclined to think that while the difference is not great, it would be about in this order: The Belpaire first, the vertical boiler next, and the horizontal tubular rather a poor third. I think there isn't a great deal of difference between the vertical boiler and the Belpaire, both giving very satisfactory evaporation. I think I should have no doubt that with our firemen, we could fill the Lynn guarantee all right with either one of them, that is, 12 pounds, or better, from and at 212° per pound of combustible, because we frequently do 10 or better with a mixture of soft coal and anthracite screenings, or buckwheat.

MR. DEAN. Do you analyze the gases?

MR. DOANE. We do not analyze the gases as a regular thing, though we have some thought of putting in some form of CO_2 recorder. It is, of course, a question whether either one of the plants taken separately is large enough to warrant it, but as we propose to enlarge the plant considerably at the low-service pumping station, it may be advantageous to put one in. I think for large plants such records are of great advantage, principally because they furnish a means of keeping tally on the work that the different firemen do. If one fireman can do a little better on his watch than another, you have something really definite and tangible with which to show the man on the other watch that this first man is doing a great deal better than he is. As has been pointed out many times, these recorders do not save anything themselves. It is only their indications which are of value, and they are of no value unless they are acted upon.

MR. DEAN. Mr. Doane's experience with reference to the relative economy of boilers agrees with what I have concluded to be the case from tests I have made; that is, I have always got better results from the locomotive type of boiler than from any other.

MR. HARRY L. THOMAS. Let me relate an experience. We purchased a carload of anthracite pea coal which proved so high in sulphur that it was entirely useless for our producer and we disposed of it for domestic use. A second carload, purchased with no more stipulations regarding efficiency or composition than applied to the first lot, proved excellent for our use; the engine ran continuously with no perceptible variation of speed or adjustment. The third purchase, made under the same conditions as far as we were concerned, and with the hope that we had found just what we needed, brought us coal that we are able to burn, but with very indifferent results. In the light of this experience I am anxious to know if there is anything practical which we can do, after having obtained a good coal, to establish it as a standard upon which to base future purchases. The coal was purchased directly from the mines in all cases.

MR. DOANE. Some pea coal, delivered from the mine, comes from the screenings where the coal is divided into sizes at the breakers; and other pea coal is washed out of the culm, or waste piles. Such coal is liable to contain a very large amount of fine slate and all sorts of dirt. It looks a good deal like coal when you see it, but it is quite different when you come to burn it.

MR. THOMAS. The trouble with the coal that we could not use was that it was very high in sulphur.

MR. DOANE. I was going to suggest that probably the sulphur might be a large item; it is probably a combination of sulphur and ash, one or both. I should think where you buy the coal a carload at a time it would be feasible, when you get a very good carload, to have that carefully tested. It would not be a very expensive operation, probably between $15 and $20. You would probably want the sulphur, ash, and British thermal units determined — there isn't much volatile matter in anthracite coal. But it would be valuable information to refer to, and from it you could make some kind of an arrangement with your dealer so that if you got another carload that was unsatisfactory you could have an analysis made of that, and, if it wasn't reasonably near the results of the test on the good coal, the coal might be either rejected or bought at a greatly reduced rate.

MR. THOMAS. One lot of coal we used was analyzed before we

used it, and while the analysis showed the British thermal units to be very satisfactory in number, it was rather indifferent coal for us to use. This test was not of so much consequence as the sulphur and ash.

MR. DOANE. The British thermal units and the ash will probably vary pretty nearly in inverse ratio, but the sulphur, of course, is an element which would be variable, and I should imagine in a producer plant the coal perhaps wouldn't have to vary a great deal in ash and sulphur to be either quite bad or very good.

MR. THOMAS. That is the point. It is either one or the other.

MR. DOANE. You have got a pretty narrow margin, you see, and you are probably worse off than a person burning it under a boiler would be.

MR. F. S. HOLLIS.* I should think that chemical analysis would be of the greatest value in the determination of the relative value of different lots of the smaller grade of anthracite coal.

A partial analysis, consisting of the determination of the loss of weight on burning, representing carbon and volatile matter and of the ash, ought to serve pretty well in determining the value of the coal for steam production. In case it is to be used in a producer the determination of sulphur and an idea of the character of the ash is, as Mr. Doane says, of much importance and should be included in even a partial analysis of a coal for that purpose.

MR. DOANE. I think in the case of a producer the sulphur would be of more importance than it would be if the coal was going to be burned to make steam, for the reason that in a producer, as I understand, — I am not very familiar with producer plants — the effects of variation, not only in the amount of ash, but in the quality of ash, are very material, so that a small variation in the amount of sulphur might change the ash from one which would be friable and easily gotten rid of to clinkers you can't get rid of, which almost completely stop the air from going through the fuel bed; consequently the gases given off are not of the right composition.

MR. THOMAS. That is precisely the difficulty.

MR. NEGUS. Speaking of boilers and coal, my experience has been that there is a great deal more difference in the firemen hand-

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ling the coal than there is in the coal itself. If one fireman doesn't know what another uses, he will use more coal than he ought to.

It is claimed that there isn't much of any difference between the Belpaire and the vertical boiler, but I am not an advocate of the vertical boiler from what experience I have had. At New Bedford we had two vertical boilers of the Corliss type, with very little combustion space between the grate and the tube sheet, which I think was a great disadvantage. We had, and we have there now, one Belpaire boiler, which I think is one of the nicest boilers that is made. Using the two types of boilers with the same engine, doing exactly the same work for twenty-four hours, there will be 1 200 pounds of coal difference. You might take three firemen and have them on eight-hour shifts, and not let one know what the others were burning, and they would run over what they actually ought to use from 100 to 200 pounds in an eight-hour shift.

I am sorry Mr. Dean has gone, because I was going to ask him to give us a few points with regard to vertical boilers. He is designing one very large boiler, and I have always been of the opinion that if there was sufficient space between the grate and the tube sheet they would perhaps do a great deal better, but we have had very poor luck with them down our way compared with other boilers.

Some years we have one grade of coal and some years another, but we don't find such a very great difference; but we do find a lot of difference in the men who handle it. Of course, when we get Georges Creek coal it requires a little more work to fire it and get as much economy out of it as you get out of some freer burning coal, or something which doesn't have to be broken up as much. We use anything which comes along, whether it is Georges Creek, New River, or Pocahontas, or whatever it is, and we don't find such a great deal of difference. One burns just about as well as the other, only one requires a little more labor than the other. The gentleman was speaking about the use of pea coal, and I will say that we burned pea coal at one time and we found that with some kinds of treatment we could get along very well with it, particularly if we kept an extremely thin fire. So I think in many cases where they have trouble it is due to the kind of use it has more than it is to the quality of coal.

MR. DOANE. I will say that the question Mr. Negus has just raised as to the height of the tube sheet from the fire or grate in vertical boilers is the vital point in the design of vertical boilers; also, that coal high in volatile matter is not suitable for vertical boilers. Anthracite coal probably is the most efficient for a vertical boiler, but coal quite high in volatile matter can be burned if you have the right proportion between the height of furnace and the length of tubes.

MR. EDWARD D. ELDREDGE.* Reference has been made to mixing anthracite screenings with bituminous coal. I should like to ask Mr. Doane if he considers that a point of economy to any extent?

MR. DOANE. We consider it economical in our work and we use as high as 50 per cent. screenings. There is a certain percentage at which the cost of pumping 1 000 000 gallons begins to increase, and we stop short of that. Our records are kept in such a way that we can tell whether we are gaining or losing by using different mixtures, and we use the mixture which seems most suitable, which, we find, varies with the load. When the boilers are being forced you cannot use as large a percentage of screenings as you can when you are going along easily, so we have to proportion the mixture to the requirements of operation at the particular time. But we do find that there is a material saving in burning it. The price, of course, has to be carefully looked into, for it does not pay to burn fine anthracite which costs above a certain price, and it does not pay to use over a certain amount in the mixture. With forced draft and proper equipment, of course a good many plants use it altogether, with no bituminous at all, but we are not equipped to burn it that way. It requires, also, a greater boiler capacity, even with the best equipment, because it has not got the heat units in it, and no matter what your equipment is, you can't get more heat out of it than there is in it. In general you will find you will have to increase your boiler equipment in order to burn it satisfactorily, and that it requires a lot more labor to fire it properly.

* Superintendent of the Onset Water Company.

THE MAIDSTONE TYPHOID EPIDEMIC.

BY WILLIAM P. MASON, PROFESSOR OF CHEMISTRY, RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

[*Read January 12, 1910.*]

In 1897 the county town of Kent, with a population of 34 000, was visited by a serious outbreak of typhoid fever, and, although in a general way we on this side of the Atlantic have had some information concerning the epidemic, yet no special presentation has been made to an American audience of the interesting features of the case. During a recent visit to the spot the writer has been enabled to secure data for the following sketch. Full use has also been made of the official report, and its illustrations.

Maidstone is situated upon the Medway River, but the water with which the town was supplied came from underground sources, being developments of a number of local springs so situated as to be utilized in three several groups. It was one only of these groups that had its water infected, and the cause of such infection is the interesting point in the case.

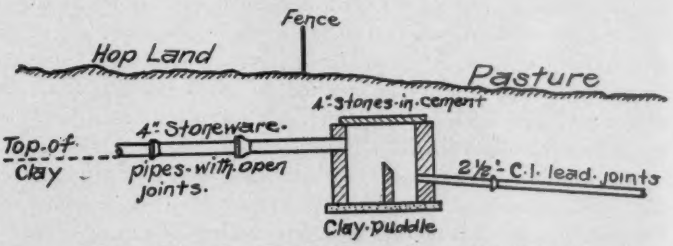

FIG. 1. CROSS-SECTION SHOWING COLLECTING DEVICE.

The present municipal supply is derived from deep wells and from galleries driven into the chalk along the plane of its junction with the underlying clay (Fig. 1), and the water so secured is excellent, but our interest is centered in the conditions as they existed in the summer of 1897.

At that time the city's water was obtained from the subsoil

drainage of a highly cultivated district where the soil is often of stiff clay, capable of ready desiccation, with formation of deep soil-cracks during periods of little rain. Through such a dried and fissured soil water can pass rapidly, and in relatively large streamlets, without securing the full advantages of efficient filtration.

A glance at the illustrations is sufficient to show that plenty of opportunity would be given for such polluting material as might be thrown upon the ground surface to pass the arable layer in times of relative dryness and reach the tile collectors resting upon the clay bed a few feet below. As to what kind of pollution might occur upon such surface, let it be said that the whole district is heavily tilled and, consequently, manured, and that the staple is "hops," a crop whose method of harvesting presents conditions both peculiar and dangerous.

Hops ripen at Maidstone in the latter part of August, and the crop is gathered by a small army of "pickers" recruited from the slums of London. During the picking season these people come down in families and settle temporarily upon the land, a large number of them living in the open, covered by whatever shelter can be secured. They are paid at the rate of one shilling for seven "baskets," an amount equal to sixty imperial gallons all told. Usually a family, children included, are assigned a "bin," which is a vessel made of sacking 8 x 2½ x 2½ feet in dimensions, and into this their pick is thrown. The green hops are placed upon the perforated floor of a "drier" in a layer 2 feet deep and are heated by a small coal fire, upon which is thrown about five pounds of sulphur, the fumes from which kill all insects that may be present, and when dried the hops are pressed into bags for market.

It is a matter of common knowledge that land containing much clay will, under the influence of summer sun, become deeply fissured provided that no rain falls to neutralize the drying effect.

From the character of the Maidstone "pickers" it is easy to conceive that typhoid might be carried to the hop-fields, and, if so carried, abundant opportunity would be given for infection to pass into the local ground water during periods of drought. Dejecta deposited upon the surface would surely be washed by the first rain into the deep cracks formed in the clay soil through the influence of desiccation.

FIG. 1.

FIG. 2.

THE HOP PICKERS' CAMP.

In 1897 the cracks in the Maidstone soil were well developed because " from June 29 to August 6 there had been no rain save on July 26 and 27," and then only 0.21 inch. It is easy to see how any polluting material deposited upon the surface, whether by the hop-pickers or others, could thus pass easily into the substrata without undergoing purification by soil percolation.

Many of us will remember the relationship suggested by Pettenkofer as existing between low ground water and typhoid fever, and the still more interesting work of the Michigan Board of Health, showing that the increase of the disease synchronized with the rise of ground water level caused by the first heavy rain following long drought.

The Maidstone experience accorded with the " Michigan rule." Heavy rain fell on August 7 and 8, the ground water level rose rapidly, and two weeks later the typhoid epidemic began. Dr. M. A. Adams pointed out that the sudden high water level was due " to the highly desiccated clay being unable to readily absorb so much moisture." Later, however, " notwithstanding occasional rainfall," the water level began to decline because of increased power of absorption on the part of the soil, and subsequently the heavy rains of the end of August caused a second rise of ground water, which, allowing for the two week's incubation period, corresponded with the climax of the epidemic. Dr. Adams shows in illustration a sketch (Fig. 2) in support of his view as to the cause of the epidemic, and pictures the deep soil cracks which he observed in the hop-lands.

It is interesting to observe the relation of the outbreak of typhoid to the rise in ground water as shown by chart in the report of the Local Government Board, although it must be admitted that the data call for a very short incubation period if we are to assign the disease to the hop-pickers as a cause. The same report also pictures in chart form the epidemic of severe " diarrhea of a somewhat peculiar kind " which preceded the typhoid and more nearly synchronized with the rainfall.

Many observers have noted and reported this tendency of typhoid epidemics to be immediately preceded by diarrheal disturbances. Whether or not the typhoid was in this instance due to pollution carried to the locality by the London pickers, or to

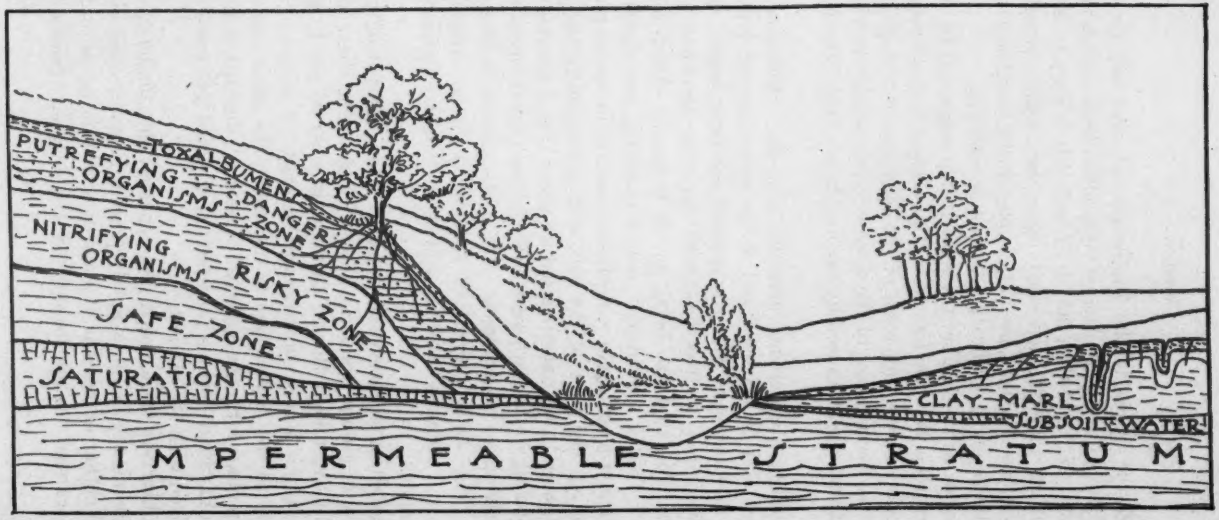

FIG. 2. Diagram illustrating Dr. Adams' theory of the effect of drought on clay in relation to water supplies.

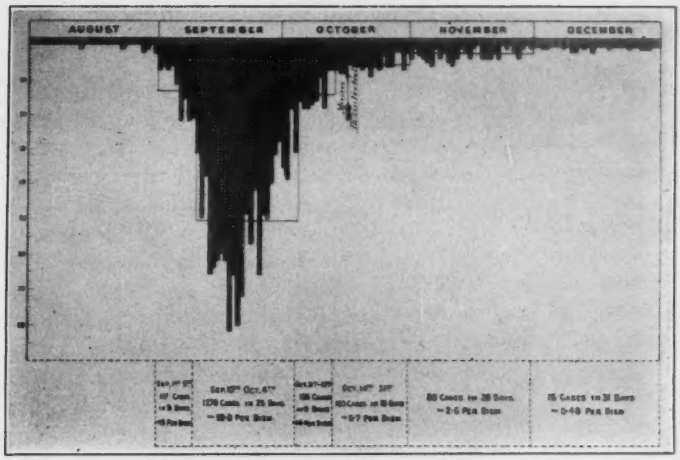

FIG. 1. Showing day by day the number of persons known to have been attacked by enteric fever in Maidstone. The arrows show the dates when the Tutsham and Farleigh supplies were cut off and when the mains were disinfected.

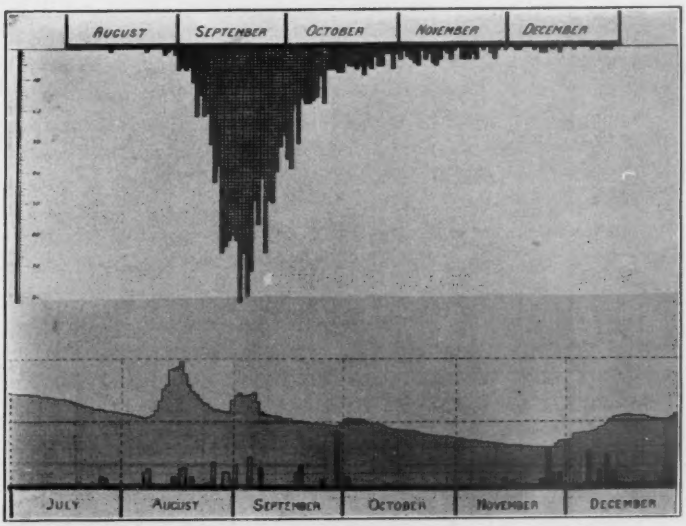

FIG. 2. Showing diagram of Fig. 1 compared with the amounts of daily rainfall (in inches) (shown at the bottom), and the variations in level of the subsoil water (in feet).

similar material of local origin, or to "the very highly and deeply manured soil of the hop gardens," the lesson for us lies in the manifest relation existing between a polluted surface soil and the underlying ground water when the former becomes dry and fissured by prolonged drought.

In view of the present interest taken in the hypochlorites for use in water purification, let it be said that subsequent to cutting off the infected water, the mains at Maidstone were flushed with a solution of "chloride of lime." The result so far as disinfection went was satisfactory, but we now know that the "dose" used was far larger than was necessary.

No less than 583 grains of "bleaching powder" per United States gallon of water (equivalent to 204 grains of available chlorine), in other words, a 1 per cent. solution, was the strength proposed for employment, but even this enormous dose was exceeded through an oversight, and the solution actually used was still stronger. It is not surprising, therefore, to learn that "nearly every tap started leaking and had to be re-leathered" and that "the fire-engine, pump-buckets, and delivery and suction hose were entirely destroyed." From our present knowledge of the very minute dose of "bleach" that will kill intestinal organisms, we are perfectly willing to endorse the belief of the Maidstone authorities that "no microörganisms of any form that could have obtained access to these pipes could remain alive and active."

DISCUSSION.

MR. R. S. WESTON.* Mr. President: It is rather interesting, I think, that while the Germans have been accustomed to consider ground water supplies absolutely safeguarded against pollution of all kinds, this English epidemic should have occurred to illustrate the great differences in ground-water supplies. Ground-water supplies which are drawn from sand, especially from large areas of fine sand, which removes the effects of all surface pollution, illustrate one type, and those which are from limestone rock full of caverns and fissures, or from the chalk, as in the Maidstone case, represent another type. We should be very careful, therefore, before laying down any absolute and fixed rule regarding the

* Consulting Engineer, Boston, Mass.

safety, or lack of safety, of any one class of water supplies, for while ground-water supplies possess great advantages, and are usually much safer than a surface water source, there are cases, as at Maidstone, where they are subject to more sudden and more extensive pollution than even some of the worst surface water supplies, for the reason that when a well does get polluted, it requires a very much longer time for the pollution to pass away than in the case of many surface supplies.

DR. MASON. Mr. President, may I say just one word as illustrating what people will do when they are badly frightened. When I was over there a little while ago they told me in Maidstone that their reservoir has a few pipes opening into the open, and that those pipes were now plugged with sterilized cotton.

DEPRECIATION IN WATER-WORKS ACCOUNTS. WITH REFERENCE TO UNIFORM REPORTS.

BY HARVEY S. CHASE, CERTIFIED PUBLIC ACCOUNTANT, BOSTON, MASS.

[*Read February 9, 1910.*]

Some twenty years ago the writer was superintendent of a water works in one of the smaller cities of New England, and subsequently became treasurer, and was also manager of the gas plant in the same municipality. During his administration the water works were rebuilt, new pumps were installed, a water tower erected, a filter introduced, and the mains extended in many streets. At the same time a complete reorganization of the gas plant went on, with new works and holders. The process was changed from coal gas to water gas, and the mains throughout the town were repaired and relaid. This was the first practical experience with questions of depreciation on a considerable scale with which the writer had to do, for, as may be surmised, no allowances for depreciation had ever been made in the accounts of the water works or of the gas works prior to that time. All these renewals and reconstructions required the investment of new capital for the time being, although this was ultimately made up out of earnings in subsequent years.

From that time questions relating to depreciation in public service corporations and in municipal industries have played a prominent part in the writer's experience, as he has been engaged as an expert witness in a number of important suits relating to water works, gas plants, and electric light works in which the determination of fair rates for depreciation was fundamental. In each case, in fact, the result of the suit depended almost wholly upon a correct setting forth of these matters. The Holyoke Water Power case was one of these suits. Boston Consolidated Gas Company, Haverhill Gas Light Company, Norwich Gas and Electric Company were others.

Having been called upon in a professional capacity to reorganize

the accounts of various municipalities during the past ten years, the accounting of public water works and electric light works has been drawn forcibly to the writer's attention. Moreover, as chairman of a committee of the American Association of Public Accountants which has reported upon questions pertaining to uniform accounts in public service corporations and in municipal industries, the necessity for correct accounting of depreciation has been further impressed upon him. The reports of this committee may be found, by those interested, in the Proceedings of the American Association of Accountants for past years.

In connection with the Bureau of the Census, special attention has been given by the writer to water-works accounts, while in 1907 a report was submitted by him to the New England Telephone and Telegraph Company which pertained especially to depreciation and kindred questions in the telephone field. These matters have been mentioned here in order to show how wide a field, in the experiences of public accountants as well as of water-works, gas, and electric engineers, is covered by matters related to depreciation.

Mr. Albert H. Wehr, at the annual convention of the American Water Works Association last June, presented an admirable paper relating to uniformity in the accounts and reports of water works, in which he refers to the recent work of the United States Census Bureau and to the conclusions of Dr. Powers of the Census in the Bureau's bulletin, "Statistics of Cities," published early in 1909.

It may be advisable for me to summarize the statements of Mr. Wehr and Dr. Powers before proceeding to my own conclusions concerning the subject of this paper.

Mr. Wehr's considerations in favor of a uniform classification of accounts are as follows:

"The evolving of any uniform classification of accounts for water supply or any other form of public service enterprise must be based on certain considerations of purely practical utility, of which the five following are the most important, viz.:

"1. To afford managers such detailed information relative to the operation of their properties as to enable the making of careful analyses of income and expense, both separately and as compared with previous similar periods.

"2. To afford accurate comparability of the operating results of such enterprises with those of any other similar enterprise.

"3. To so divide and subdivide the expenses as to easily enable the ascertainment of the separate and distinct elements of cost which make up the total cost of service. . . .

"4. To so devise the scope of the classification as to place the enterprise, whether privately or municipally owned and operated, on a basis which will disclose all income earned by the enterprise, whether actually received or not, and show the actual expense of operation or cost of service, whether actually paid or not.

"5. To so devise the classification as to divide the various branches or departments of such classification into certain fixed and clearly defined centers of division, from which all subdivisions radiate. . . ."

In this connection, Mr. Wehr has devised a scheme of enumeration for the classified accounts which is simple, effective, and cleverly arranged. Mr. Wehr's paper sets forth definitions of the classifications, following in the main the terms accepted by the Census Bureau, and gives a complete scheme of the classified accounts under these heads:

1. Income Accounts.
2. Expense Accounts.
3. Allocation and Profit and Loss Accounts.
4. Outlay, or Property Accounts.
5. Asset Accounts.
6. Liability Accounts.
7. Proprietary Interests, or Proprietorship.

In this classification *depreciation* appears under various headings, the first of which is 214, "Expenses for General Depreciation," with subdivisions as follows:

2140. Undistributed Expenses for General Depreciation.
2141. Depreciation of Administrative Property.
2142. Depreciation of Accounting and Commercial Property.
2143. Depreciation of General Operating Property.

Also under the heading 224, "Expenses for Water Service Depreciation," appear the following subdivisions:

2240. Undistributed Expenses for Water Service Depreciation.
2241. Depreciation on Sources of Supply Property.
2242. Depreciation on Intakes and Aqueducts.
2243. Depreciation on Purification System.
2244. Depreciation on Pumping Station.

2245. Depreciation on Transmission and Distribution Storage System.

2246. Depreciation on Distribution System.

2247. Amortization of Preliminary Expenditures.

And under 23, "Miscellaneous Expenses," appear

23115. Depreciation on Tools and Appliances — Plumbing.

23125. Depreciation on Buildings, Tools, and Appliances — Shops.

23136. Depreciation on Buildings, Teams, and Equipment — Stables.

23144. Depreciation of Rental Property.

23155. Depreciation on Tools and Appliances — Meters.

23164. Depreciation of Forest Lands and Reservations.

23174. Depreciation of Other Accessory Enterprises.

Under 232, "Expenses of Invested Funds," there is an item 2322, "Expenses of Depreciation Funds"; also 325, "Depreciation in Invested Funds Values"; and 342, "Depreciation and Amortization Funds." Among the assets under the general heading 5 appears 563, "Depreciation and Amortization Funds."

No accounts appear among the liabilities under general heading 6, where we should expect to find "Depreciation Reserves." This fact particularly appeals to me, as it is the special point on which I must criticise the otherwise admirable and exhaustive classification of Mr. Wehr. No explanations of Mr. Wehr's views concerning depreciation reserves appear in the text of his paper, but in the Census Bulletin, on page 334, the term "depreciation" is defined as given below. In the Census classification, depreciation accounts appear under the following headings:

VII. Expenses for Water Service Depreciation.

208. On General Administrations Buildings and Equipment.

209. On Accounting Equipment.

210. On Operating Management Buildings and Equipment.

211. On Sources of Supply.

212. On Intakes and Aqueducts.

213. On Purification System.

214. On Pumping System.

215. On Transmission and Distribution Storage System.

216. On Distribution System.

There are also accounts for depreciation of pumping, rental property, meters, stables, etc., these being in accord with Mr. Wehr's classification. The Census definition of depreciation is as follows:

"*Depreciation.* Depreciation is a general designation of the gradual diminution in value which is caused by wear, decay, displacement, or obsolescence in the value of buildings and equipment, and of the sudden diminution which results from fire or other destructive forces. It is never actually or relatively the same for any two establishments, even of the same industry. For this reason it is impossible to frame concise, general rules for making allowances for depreciation which will not in their application be attended with a large margin of possible error. To use such rules without causing errors, those employing them must have for each individual establishment exact data based upon inspection, showing how far and in what respects its actual depreciation differs from that of the average establishment of its class. For this reason, a physical examination and appraisal of water works should be made every ten years, or even more frequently, in order to provide the basis for an approximate statement of the annual loss chargeable, as an expense, to depreciation. In the absence of such exact data for each water-supply system, however, it is to be assumed that depreciation takes place according to the average life of the several parts of such a system and of water-supply plants as a whole. The knowledge at the command of the Bureau of the Census leads to the conclusion that this average life is approximately as follows: For horses, carriages, automobiles, and laboratory fixtures and meters, ten years; office furniture and general equipment, fifteen years; boilers, steam pipes, and filtration equipment, twenty years; engines, pumping machinery, and wood pipes, twenty-five years; masonry of filtration plant, cribs, iron water pipes, intake pipes, fire hydrants, standpipes, and buildings, fifty years; reservoirs, tunnels, and aqueducts, one hundred years; and for the water system as a whole, fifty years.

"There are many methods which may be employed in the computation of depreciation from data such as are above referred to, all of which involve the assumption that depreciation proceeds either with a uniform or with a geometrically accelerated rate

throughout the life of the plant or fixture. The actual rate of depreciation unquestionably increases geometrically, and for this reason the best method of computing the amount of depreciation which has taken place during a series of years, or during a particular year, is that which is sometimes called the sinking fund or compound annuity method. The depreciation during the first year of any property having an expected life of fifty years is represented by a quantity equal to the annual payment which would have to be made each year during the fifty years, and invested at some specified rate of interest, to amount at the expiration of the fifty years to a sum equal to the original value of the property. The depreciation for any subsequent year would be the same quantity plus an amount equal to the interest on the prior payments and accumulated interest earnings at the specified rate. . . . By means of tables and diagrams, the depreciation for each particular portion of the water-supply system can be computed for any given year of its life, and thus the total depreciation for the system be ascertained, provided the enterprise has a detailed statement of its property and equipment as explained later under 'tentative instructions for accounts, with cost and present value'; and, provided further, that the probable life of each division of the system has been ascertained by physical inspection, and that the rate of depreciation has also been determined in the same manner. The depreciation taking place in the water-service system in a given year, calculated as above, should be charged as an expense in primary accounts 208 to 216. This depreciation, however, is primarily an entry in the accounts with property and equipment, as shown in the accompanying summary of the cost and value of the water supply system and of its extensions, additions, and renewals. When detailed data are lacking for computing depreciation as outlined above, it may be assumed that the aggregate depreciation to be included in the accounts mentioned, or in subgeneral account VII, is 2 per cent. of the present value of the water system. . . ."

The Census classification for water-works accounts does not set up a complete balance sheet of assets and liabilities, nor does it give a detailed list of liability accounts, in which should appear,

according to the writer's opinion, a series of depreciation reserve accounts. It is owing to this omission, both in the Census classification and in Mr. Wehr's, that the present paper has been written, and the writer will, therefore, give a brief explanation of his reasons for urging the inclusion of depreciation reserves in all such classifications.

Much experience under the conditions in which public service corporations are acting in most municipalities convinces the writer that it is fundamentally necessary that questions of depreciation should be carefully considered, accurately worked out, and regularly entered upon the books of all such corporations. This being the case in private works, it is also necessary that municipally managed public services should have similar accounts. The reason in both cases is the same, viz., in order that *fair* rates may be established, that is, rates which will be just to the consumers and also fair to the plant. Such rates cannot be just unless full allowances shall have been made for deterioration of the plant, or, in other words, for the capital losses which arise from depreciation. Such losses must be provided from income, or otherwise they will require new capital. Therefore, they should be handled in the accounts as regular charges against income. This is most forcibly true in all plants which have to do with electricity, for in such plants depreciation during past years has been rapid, and changes in the art have frequently demanded that machinery should be scrapped even though the machines themselves might be in excellent physical condition. Electric street railway companies, electric lighting companies, and telephone companies are fast coming to see the necessity for proper and complete provisions for depreciation. Gas companies are next in importance in this particular, while water works may be considered last. It must be noted that it is frequently the fact that "appreciation" in the general value of any water works, due to increase of population in its territory, may offset in great part, and sometimes may even exceed, the losses by depreciation which occur during a given period. Therefore, while the emphasis which is here laid on depreciation accounting is accepted in full by electrical concerns to-day, and accepted in part by gas companies, it is nevertheless true that water works have not as a rule acknowledged

the necessity for such accounting, or, at least, have not adopted such accounts in their bookkeeping systems. The same arguments which have compelled the use of depreciation accounts in electrical concerns will, in my opinion, compel their use ultimately in water works. This will come about mainly through the instrumentality of state supervising boards, which will require uniform reports from all municipalities and from their departments, in which a water department is frequently included.

Just as the Gas Commissioners of Massachusetts have required definite allowances for depreciation in the accounting of municipally operated plants, so, in due time, similar requirements will be promulgated for municipal water works.

If the writer has stated the facts correctly, and if his deductions in regard to the future are true, it is evident that proper accounting for depreciation should be undertaken promptly in all such plants. The best way to handle these matters, in the writer's opinion, is by a series of *depreciation reserve* accounts, that is, by reserve accounts which correspond to the different classes of assets, and which appear in the balance sheet as liabilities (credit balances). Every monthly closing should provide for items to be charged to *expense* and at the same time credited to these various reserve accounts. Each of these charges should be based upon a carefully calculated percentage which will vary according to the estimated life of the particular class of asset. Whenever depreciation is made good by actual expenditure for renewals or reconstruction, such amounts should be charged against the corresponding depreciation reserves and thereby the balances remaining in these reserve accounts will show whether or not sufficient monthly allowances are being made year by year to provide for depreciation losses, shown by the actual expenditure for renewals and reconstructions. The necessity for depreciation reserve accounts being evident, the writer urges that particular attention be given to them in all public service accounting, and trusts that, in future editions of the Census classifications, statements of liability accounts will be included in which will be set forth in detail a depreciation reserve for each of the various classes of deteriorating assets.

If what he says here will, in some measure, bring the importance

of such reserves forcibly to the attention of practical bookkeepers and managers of public services, the writer will have accomplished all that was intended by the preparation of this paper.

DISCUSSION.

MR. HARVEY S. CHASE. This question of depreciation in connection with public service corporations is, it seems to me, one of the most important questions which can be discussed. It happens that I have been called upon in litigation in connection with public service corporations in a number of different cities and towns in New England and elsewhere, and in every case that I remember the question of depreciation was a fundamental one, both in the matter of what are fair rates and in the problem of establishing a fair price for a municipality taking over a water works. In both those classes of cases, and those are the two which are the common ones in public service corporation litigation, and particularly in connection with gas and electric light plants, that has been the important point.

Three years ago, I think it was, we were called in by the New England Telephone and Telegraph Company to make an investigation of their bookkeeping, particularly with reference to depreciation. We endeavored to make a very thorough study of the situation there, because the question of rates with them, of course, is singularly important, as they cover such a large territory. Since that time the Highway Commission under the new law has taken charge of establishing rates and controlling the company in the same way that the Gas Commission controls the gas and electric light companies. At the time we made our investigation the telephone company had no depreciation reserve accounts, and it is on that subject that I should like to elaborate somewhat.

In any public service corporation, and more particularly in public service corporations where deterioration is rapid, this question of depreciation is very important. In all electric enterprises, — street railways, electric light plants, telephone and telegraph companies, — everything connected with electrical devices deteriorates rapidly, and, further, a very considerable amount of obsolescence ensues on account of the rapid development

of the art, so that machinery which was good at the time it was put in, and which has been in but a short time comparatively, may have to be thrown out, although its physical condition is excellent, because new machinery has been invented which must necessarily supersede the old. Now, unless provision is made in the accounts of corporations, public service corporations particularly, whereby these losses and costs from depreciation are paid out of income, there ensues naturally a capital loss. Either there must be sufficient income laid aside to provide for depreciation in all its forms, or we will have a shrinkage of capital. There can be no escape from that proposition.

Frequently we hear depreciation spoken of as if it were not an element of expense. It *is* an element of expense, just as much as salaries, supplies, wages, or any other element which we ordinarily charge to maintenance or operation of the plant. It is a fact, however, that it is much more difficult to provide for, and much more difficult to calculate, than are these items, and the only way in which satisfactory provisions for depreciation have been arranged in public service corporations to my knowledge is by the establishment of " depreciation reserve accounts."

I suppose the great majority of you know exactly what I mean by depreciation reserve accounts, but in order to make it clear to those who do not, I will endeavor to explain briefly and simply. Let us suppose that at the end of a month we are going to charge up against income all the expenses of that month. We charge, of course, for all the expenses of operation, for all the expenses of maintenance, and by " maintenance " I mean repairs of the plant, and *an estimated amount for depreciation.* Very few water works, I imagine, to-day make such a monthly charge for depreciation calculated in a scientific way. My contention is that we must all ultimately come to making exactly that charge for depreciation monthly in all accounts. We make that charge against income on the one side, and set it up in our account on the other side of our ledger as a credit to one or more depreciation reserve accounts. There should be, in my opinion, a depreciation reserve account for each of our different classes of assets.

Now we have made a charge against income in our account, calculated on the basis of percentages according to the life of the

different portions of our plant; we have set it up in a series of depreciation reserve accounts on the other side of our ledger; and we do that every month, thereby accumulating a series of credits standing in the ledger accounts. When we come to the question of renewals, which ordinarily on a cash basis we should charge against income, instead of charging it against income we charge it against one or the other of these depreciation reserve accounts. We have already charged income, you see, with the estimated amount of depreciation; now we charge against that depreciation reserve the actual costs of renewals. That is to say, when we make a renewal or reconstruction of pipe, we charge it against the depreciation for mains; when we make a renewal of plant, pumping plant or otherwise, we make it against the depreciation reserve for plant, for pumping plant, and so on down through the list.

While this matter is not so important in water works as it is in other classes of public service corporations, for the reason that deterioration does not go on so rapidly in water works as it does in the other public service corporations, it is still equally important when we come to discuss the question of what are fair rates for water works. We can all see that, if we have depreciation going on, as there frequently is in electrical concerns, amounting to 10 or 15 per cent. or more per annum, unless we provide for that carefully, so that our rates to consumers will allow us to lay aside moneys to make good that depreciation, we shall not be charging rates which are fair to the companies. Those rates must be so established as not to be below the point where proper depreciation can be taken care of. That is just as important in water works, in kind, though not in degree, as it is in telegraph companies, telephone companies, street railway companies, or gas and electric light plants.

The distinction between new construction, reconstruction, and ordinary repairs is one in which, I imagine, all of you gentlemen are more or less entangled. Everywhere I go I find that the managers of public service corporations are at a loss for a proper definition of what is "construction" (to be charged to assets to increase those assets), what is "reconstruction" or "renewals" (which should be charged against depreciation reserve),

and what are " ordinary repairs " (which should be charged against the income of the month, just as wages are). The distinction which is made in the big public service corporations between reconstruction and repairs is usually made in this way: Whenever a piece of work is big enough to justify an estimate beforehand, so that the exact cost of the reconstruction or renewal is to be estimated and passed upon by the officials before it is authorized, that is considered a reconstruction or renewal item and is charged against the depreciation reserve. All other items, which are simply passed upon in the ordinary course of business, without a requisition or appropriation beforehand, are considered as repair items and are charged to the ordinary monthly expense. That distinction, particularly when you are dealing with an electrical concern, is exceedingly important, and it is only a question of time when it is going to be equally important in water works. We can already see it in many places in the West. For instance, the city of Denver, which has private water works, is in discussion with the water company and is threatening to take over the works. The question of the depreciation of that plant, and the question of what is a fair price to be charged, are now under most searching investigation. And so it is in cases which have come up nearer home. I might refer to the Holyoke Electric Light and Gas case, with which you are familiar, which was settled wholly on the question of depreciation; to the Haverhill Gas Company case, which has been very prominent; to the Norwich case, the New York Consolidated Gas case, the Boston Consolidated Gas case, and so on. They all came down to this question of depreciation. And yet I venture to say that in the majority of the books of the corporations which you gentlemen administer there are no regular, scientifically estimated depreciation reserves, although doubtless there have been in a great many of your works careful provisions for depreciation.

But take private corporations, for instance, and how do they provide for depreciation to-day? The great majority of private corporations make no calculated provision for depreciation. In a good year, when they have made a great deal of money in excess of what they should distribute as dividends, they lay aside ten, twenty, thirty, or one hundred thousand dollars and call it a reserve

for depreciation, without any calculation or any knowledge on their part as to whether or not it is the right amount to lay aside; it is an amount that they have available, and they lay it aside. That may be very well in the case of a private corporation, a close corporation, where if they lose one year they make in another, but it will not do for a public service corporation which has its own relationship to the public, and whose rates are established by the character of the service and the cost of the service that it renders the public. A public service corporation is entirely different from a private corporation. The new corporation tax law which has been recently passed requires all corporations throughout the country to make careful provisions for depreciation and to state these provisions in their returns to the Internal Revenue officers, with the penalty that if they fail to make such provisions for depreciation and to deduct them from their income, they will have to pay a larger tax than they would otherwise pay. It seems to me, even if the corporation tax law should be declared unconstitutional, and should be thrown out, that the fact that it has brought to the attention of corporations throughout the country the necessity of providing for depreciation in their accounts, and setting it up intelligently on their books, will be worth all the cost of that act, both to the federal government and to the corporations themselves. There are a number of other provisions in that act which are, perhaps, equally as important, but that particular provision for depreciation is right on the line of our discussion.

In the last part of my paper the question of depreciation reserve accounts is considered, and comment is made upon the papers of Mr. Wehr, presented to the American Water Works Association, and upon the conclusions of Dr. Powers, which were published in the Census Bulletin "Statistics of Cities" early last year, in which you will find a number of depreciation accounts. In both cases depreciation is very well handled in these standard forms of accounts, as suggested by Dr. Powers and by Mr. Wehr, but it is handled only from the point of view of charging depreciation against income. There is no provision in either of these papers for establishing depreciation reserve accounts on the other side on the ledger, against which the actual money expenditures for renewals and reconstruction should be entered. This is the

point of my paper, and the point which I desire to bring to your attention to-day, — the necessity and advantage of establishing "depreciation reserves" which are credit accounts, and against which the actual renewals of the year should be charged, so that running over a period of time, say ten years, with such accounts it would be evident whether the total of your actual costs of renewals and reconstruction are the equivalent of the amounts which you have laid aside and regularly charged against income each month. By these regular charges against income each month, you get a true comparison month by month of the costs of running your works. If, on the other hand, as is frequently the custom, the amounts of renewals and reconstruction are charged against income whenever they occur, you get one month with a heavy expenditure, or one year with a very heavy expenditure for reconstruction, and the next period with a low expenditure.

Depreciation is going on all the time, whether we recognize it in our books or not, and if we do not make it good by regular charges, we shall be obliged to make it good all at once when we have to. We have a battery of boilers, perhaps, which are depreciating all the time; we repair them constantly, but by and by we get to the point when they are beyond repair, and we have to throw out the whole battery and put in new. This — the throwing out of the whole battery — would be a proper charge against depreciation reserve. The repairs which we have made upon those boilers from year to year would be a proper charge for maintenance to be carried against income. This distinction is the one that I should like to impress upon you, if I can, as the result of our experience on these various lines. It would not be so emphatic if we had had to do only with water works, but, seeing how important it is in other classes of public corporations, there is no doubt in my mind that it will come to be equally as necessary and equally as required by state boards of control from water works, as it is now in the case of other public service corporations.

Mr. Elbert Wheeler.* Mr. President, I want to express my thorough approval of the remarks of Mr. Chase. I think they are perfectly sound, and the managers of our public service cor-

* Treasurer of Water Companies, Boston, Mass.

porations will not be justified in conducting their business without full attention to the details he has mentioned.

He spoke of the necessity of providing for renewals of integral parts of a plant through this depreciation reserve fund, by fixing rates which shall provide therefor. In the Knoxville Water Company case, in which our people are interested, and which, I presume, is familiar to many of you, Mr. Justice Moody, of the United States Supreme Court, said, in effect, this: That it is the duty of all public service corporations to fix rates which shall provide for depreciation, and that they are without excuse if they fail to do so; and, further, that they cannot be allowed, through having made insufficient rates in one period of time, to make rates in a future period calculated to make up the deficiency resulting in the previous period. That emphasizes the importance of providing for sufficient income to cover depreciation out of current rates, from time to time.

I wish simply to add that we have already entered upon the measures which Mr. Chase proposes, excepting, that we shall not make the accounting monthly, but periodically,— probably annually,— although we recognize the desirability, in the case of some corporations, of providing for such accounting more frequently than once a year.

Mr. Allen Hazen.* We all know, as a matter of practical experience, that it is necessary to mark off something for depreciation on a water-works property in order to keep it solvent.

As a matter of business it is just as necessary and just as important to know what the depreciation really is, and to mark it off, when the plant is owned by a municipality as it is when it is owned by a private company. This is a point that I want to emphasize strongly, for I believe in it fully. Water works that are owned by municipalities ought to be managed just as carefully, on good business self-supporting lines, as though they were owned by private corporations and had to earn dividends.

The annual amount that ought to be marked off for depreciation is a very troublesome matter to determine. It has been my idea that the best that could be done was to approximate that amount as closely as it could be done on the basis of available

* Civil Engineer, New York City.

information as to properties that have been long in use, in case of doubt making the allowance above the truth rather than below the truth, and mark it off each year. After a few years compare the book value of the property carried forward in this way with the actual value, as it can be appraised at the time, and see how they are coming out, and increase or decrease the allowance for depreciation according as your book value is underrunning or overrunning the true value.

This is a crude procedure, but at present it seems to be the best that can be done, and the fact that it is crude and that the amounts cannot be determined with precision should not be allowed to stand in the way of the recognition and application of a principle that we all recognize as essential to the best management of water-works properties.

MR. GEORGE A. KIMBALL.* Mr. President, I have been very much interested in Mr. Chase's remarks on the importance of charging off a certain annual sum for depreciation. The system should be adopted by all cities and private companies. There is considerable difficulty in arriving at a proper ratio or percentage. For instance, take the question of the life of cast-iron pipe. Some engineers put its life at one hundred years, and I have seen a good many specimens which would seem to be good for that length of time; while other engineers place it at fifty years, and still others at only twenty-five years. Gates, valves, and hydrants are sometimes estimated at one half the life of the mains. In pumping plants the life of the boiler is estimated at from fifteen to twenty years, pumping machinery at a little longer time.

In regard to a proper sum to be charged off each year, I have frequently used 2 per cent. on the whole plant as a fair charge for depreciation, this to cover general deterioration, obsoletism, and renewals.

MR. CHARLES W. SHERMAN.† I am glad that Mr. Hazen has emphasized the point that depreciation is just as much a matter of importance to a municipally owned plant as it is to a private plant. It is undoubtedly a fact that in a very large percentage, if not in all, of our municipally owned water works the accounts

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† Principal Assistant Engineer with Metcalf & Eddy, Boston.

which we see published in the reports, and presumably the only accounts kept, are those of receipts and expenditures, and in no sense a profit and loss account. Rates predicated on such accounts are, of course, matters of guess work, just as much as they are in any concern where depreciation is neglected, or where other items of expense are not brought in. The question of rates is a live one just at present in the town of Belmont. We have the matter under discussion there, and I hope we shall be able to work things out on a proper profit and loss basis with the data which have been obtained in past years. We ought, I think, to be able to estimate the value of the plant fairly closely, so that a proper ratio of depreciation for the term since the construction of the works can be fixed. That is not so easy in many other places, where other and more complex items come in. As most of you know, we, being in the metropolitan district, do not have to maintain a pumping plant, and the distribution plant only has to be considered. Nevertheless, the matter of functional depreciation, that is, the outgrowing of the plant, has to be considered, and it is still pretty largely a matter of guesswork as to how long a pipe can be made to last, not so much on account of rusting out as on account of having to be replaced by larger pipes. That suggests a point which Mr. Chase did not elaborate, which I should be glad if he would say a few words on, and that is that when it becomes necessary to renew a portion of a plant in any growing community, it is usually necessary to renew it with a larger and more expensive piece of apparatus; and in that case it would seem to me as if a part only of the renewal should be charged against the depreciation fund, and the balance should be charged to new construction.

Mr. Francis W. Dean.* It seems to me that there is a great deal of education needed on the part of cities and towns, and especially the smaller towns, in regard to matters of this kind. It would seem that it would be necessary, before a depreciation account was established, to teach the officials of the town something about a proper way to keep their accounts of anything. For instance, an appropriation is made by a town for the waterworks department, and the money is thrown into the treasury

* Mill Engineer and Architect, Boston.

and is used for the purchase of spraying apparatus for moths, or for the selectmen's salaries, or for anything else; there is no separate account whatever kept. Of course, it is only common sense that there should be a depreciation account, and I fully agree with Mr. Chase in everything he has advocated, but I must confess that the manner in which town accounts and finances are usually run passes the understanding of any sensible man.

Mr. Frank C. Kimball.* I thoroughly agree with the idea that has been expressed, that a depreciation reserve is as much a part of the operating expenses of any plant as are salaries, repairs, or maintenance; in fact, somewhat more so, perhaps, because through proper management other expenses can be to some extent diminished, but depreciation itself, although we do not know to what extent, is substantially fixed. I think there can be no question about that.

In that connection, I think, perhaps, the method of handling depreciation, as stated by Mr. Hazen, can be worked out in a way which will accord with the decision as rendered by Mr. Justice Moody by making the estimate for depreciation large enough at the start and then scale it down when you find by experience that it is too much. Mr. Justice Moody says you cannot make up arrears of depreciation, but he does not say that you cannot make it large enough at the start to be sure of reimbursing the works or the department.

I think there is no one here to-day who will have the temerity to state in terms of a specific sum or percentage the amount which should be laid aside yearly for depreciation upon any water-works plant, or upon any part of it. Those of us who have given more or less time to the study of this question know that the opinions — and it is at the present time purely a matter of opinion — of those who have investigated this question to as full an extent as it may at present be investigated, differ, and we can only let time and experience work out just what is the proper amount.

I believe that the question of depreciation is just as much, and as important, a question with water-works plants as it is with electric light or any other plants. The only difference is in the

* Civil Engineer, Boston, Mass.

amount. In water-works plants, the various component parts do not depreciate as fast as do those of certain other corporations, public service corporations particularly, but that depreciation does go on is without doubt. There are other features than the mere normal wearing out of water pipe in itself that enter into the problem. For instance, in Cambridge, I can readily understand how electrolysis may affect the life of pipe and in such a slow, insidious way that you cannot say definitely that electrolysis is the cause of the trouble, — that is, to a point where you can charge it up to the electric light or railway company. But still, comparatively rapid deterioration is going on, and this as well as other circumstances must be taken into consideration. That the establishment of a depreciation reserve is a necessary policy which should be followed by every water plant, whether municipally or privately owned, there is no question in my mind.

The question has been raised here this afternoon as to how a city, for instance, which establishes a depreciation fund or reserve can be prevented from spending it in other ways and methods than that for which it was created. You can do it in just exactly the same way that a sinking fund is taken care of; that is, by having an actual contribution made to such a fund, and then have it placed in charge of and invested by the sinking fund or other commission that may be appointed by law for that purpose, and providing that it be used only upon proper certificate of the controlling officers of the plant that it is required to make good such replacements or reconstruction of the plant as are properly chargeable against that fund. There is really no difficulty in the way, and I think the sooner all companies or departments come to the conclusion that the depreciation is as much a fixed charge as interest or other expense accounts, and proceed to provide for it, the better off they will be.

Mr. Leonard Metcalf.* Mr. President, I am exceedingly glad that Mr. Chase has brought this matter up, because it seems to me of great importance.

I think Mr. Kimball hit the nail on the head exactly when he said, "Make your depreciation large enough." That is in accord not only with good policy on the part of the private corporation,

* Of Metcalf & Eddy, Boston.

but I believe it is sound public policy; for the public, certainly, cannot benefit either by seeing the plant actually divided by having funds disbursed as dividends which should have been retained for depreciation, nor can it benefit by having the rates so small that the plant cannot earn its depreciation account.

Mr. Kimball is quite right, too, in what he says concerning the amount of depreciation; it varies, of course, in different cases with local circumstances. I would, however, call your attention to the important fact in this connection: that unlike electric light plants or gas plants, the amount of depreciation in water-works property is small, and while it may differ in individual cases to the extent of from three quarters of 1 per cent. per annum to 1½ or even 2 per cent. on the cost of the plant, the effect of this difference in depreciation is very small when pro-rated upon the rates of the individual water-rate payers. Under these circumstances it is a far wiser policy to make liberal provision for depreciation and then at intervals reduce the amount charged off for depreciation if it is found to be excessive than to run the risk of failing to collect enough to cover the actual depreciation.

Just one word as to what effect this would have upon the rates. The essential difference, as I view it, between the electric light or gas company's position, referred to by Mr. Chase, and that of the water company, is that the percentage which the gross annual income on the water company's property constitutes of that entire property is very much less than in the case of the electric or gas company. The gross earnings on water-works properties vary, broadly speaking, from 10 to 15 per cent. per annum of the value of the works. That is, on a plant having a value of $100 000, the gross income may be from $10 000 or $12 000 to $15 000. In the case of the electric light property, on the other hand, the gross annual income is not 10 to 15 per cent., but from 30 to 40 per cent. But the depreciation in the case of water-works property is only, let us say, 1 per cent. or thereabouts, — it may be from 1 to 2 or more per cent. That would be, on a property of $100 000, a depreciation of $1 000 a year, and would amount to from one tenth to one fifteenth of the gross annual income. In the case of an electric plant, the depreciation might be 5 or more per cent. of the value of the plant, or $5 000 or more

on a $100 000 property. You have, therefore, in the one case to distribute a depreciation of $1 000 on $12 000 to $15 000, and in the other case you have to distribute $5 000 on $30 000 to $40 000, or from one sixth to one eighth of the value of the plant. On that basis, you see, small as it is, in per cent. of value of the works, the amount of the depreciation found in water-works property becomes nearly as considerable a percentage of their annual gross income as is the depreciation in the case of electric or gas property.

I want to make an appeal to you for such information as you can give me regarding the depreciation in your individual plants. I happen to be at the moment on a depreciation committee of the American Water Works Association, which is trying to gather statistics of this sort, taking the records, the histories, of such plants as we can get information from, and attempting to find out what has been the actual experience in those individual plants in depreciation, — that is, what mains have had to be abandoned and relaid, what pumps, piping systems, or reservoirs have had to be abandoned, in the hope of getting a little more specific information upon which we can base our estimates of the actual depreciation in water-works property,— and I should be very grateful to any of you who have any specific information along those lines, particularly those of you who have been connected with any one system of water works long enough to know the history of the works, if you could assist me in getting some such information.

MR. DEAN. I should like to ask if it would be practicable to have the findings of this committee, to which Mr. Metcalf refers, published in our own transactions, when the report is made? I don't know whether anything of that sort is allowable, but if it is not, it would seem as if it might be advisable to have a committee of our own, and if the personnel of that committee could be the same as that of which Mr. Metcalf speaks, it would make the labor a good deal less.

THE PRESIDENT. That matter can be taken up by the Executive Committee at their next meeting, and we will see what we can do.

MR. SAMUEL H. MCKENZIE.* Mr. President, I think the

* Superintendent of Water Works, Southington, Conn.

remarks of Mr. Dean appeal to a great many of us who come from the small places. I am from one of these small towns which I presume he had in mind, but I am glad to report that our present town clerk has opened a set of books which are a credit to our town. I think those of us who are connected with water departments are realizing more and more each day that our accounts should be kept in a more systematic way.

The passing of the Corporation Tax Bill by Congress has made it necessary to establish a depreciation account, which is something, as Mr. Chase has already said, that few water departments, especially the smaller ones, have been in the habit of keeping. Some might like to estimate the depreciation large enough to get their net income under the $5 000 limit, but I doubt if the Internal Revenue collector would consent to that.

There are very few manufactories who have not figured the cost of the articles they make, but how many water departments know the cost of the water they furnish, or the proportional charge which should be made for different classes of fixtures. Often, it seems as if the rates were guessed at without any idea of the cost of delivering the water, or the depreciation of the plant. There are very few systems in which the cost per million gallons of water furnished is identical on account of the varied conditions under which they have been built, but, nevertheless, I believe with a more systematic accounting that data could be obtained which would be of great value.

If the Association can assist in helping to establish a uniform system of accounting so that the percentage of depreciation of different parts of the plant may be determined and more equitable rates made, it will be performing a service which will be appreciated by the members, and I believe a committee should be appointed to take the matter under consideration.

MR. EDWIN C. BROOKS.* I was thinking, Mr. President, as the gentlemen have been speaking of depreciation, that if you could have seen some of our 40-inch steel pipe when we uncovered it eight years ago, you would have thought that about 100 per cent. should be charged for depreciation. However, with a few pine plugs and some cover-plates bolted on with rubber gaskets

* Superintendent of Water Works, Cambridge, Mass.

under them, we managed to repair the pipe while it was in use, and since that time haven't heard a word from it in any way, shape, or manner. Of course, we are not taking it up to find out whether there is anything the matter with it, for we are satisfied to "Let sleeping dogs lie."

But, really, on the question of depreciation, we have mains that have been in use fifty years which are doing just as good service to-day as they did forty years ago. We cut into them occasionally and find them perfectly good. We have got other sections where Mr. G. A. Kimball has got in his work, and those pipes need to be renewed about every year or every two years. Of course, that is one of the things we didn't have to contend with years ago.

I realize fully that depreciation is a matter of vital importance in water-works management, and I think the water-works plant that is the oldest will suffer most in depreciation, for this reason: Years ago there wasn't that thought given to the sizes of distribution mains that there has been in recent years. Long lines of small pipe were laid without any idea of reinforcing them, fire service was not what it should be, and, consequently, certainly in our own case, a great deal of main pipe has been renewed which, had it been put in of the proper size in the first place, would have probably continued in use for a great many years to come. Our steel mains were put in with a great deal of fear on the part of some that they were going to give us trouble, but, as I say, other than for that little trouble we had about eight years ago, we have had no trouble whatever from them.

Mr. George A. Stacy.* Mr. President, we all must recognize that this is a vital question. I have been with my present works twenty-six years and, so far as the pipe line goes, whenever I have had to cut into a pipe I could detect very little deterioration. Last summer we cut into a 12-inch main which was laid in 1883, and, although it had been there twenty-six years, I couldn't see but that it was good for twenty-six years more. Our works, like many others, were built by a committee of business men who figured pretty close, and, having had no previous experience, they laid some 4-inch pipe in a district which never ought to

* Superintendent of Water Works, Marlboro, Mass.

have been piped that way. In fact, the only disagreement or discord I ever had during my connection with these works was when I questioned the advisability of laying 4-inch pipe. I took some of that pipe up about four years ago and put in a larger pipe. Those men were some of our best business men, but they had not had experience with water works; they looked at the first cost, and a 4-inch pipe would deliver all the water that that district needed then, for it was thinly populated and rather on the outskirts. We had a fire in a barn out there, and the firemen couldn't get near enough to it to get the water on to the barn with the force they had from that line. Fortunately, from one point of view, the barn was a wreck before the fire was discovered, so that the lack of water didn't cut much, if any, figure in the loss of property, but I didn't have any trouble in getting that 4-inch line renewed immediately.

That brings to mind that this is a question, perhaps, of the deterioration of a plant, and there are many things that occur to you as you look back on your experience that go into this question to which you cannot see the answer. However, I believe that there is something we can arrive at which will help us out of this.

For instance, take the boiler plant. I have got one plant pumping against 180-pounds pressure, over 408 feet head, and it calls for 120-pounds steam pressure. Those boilers may be condemned by the State Board of Inspection and cut down to 115 pounds. The result is that those boilers have got to go out; we can't run on 115 pounds economically. What are we going to do with them? It is a question what the boilers would sell for. After you get them out on the ground, those who have been through that thing know about what they are worth. All those matters and hundreds of others come into your mind in solving this problem. I have got an old Blake pump that has been running almost every day all these years. It is one of those old tandems, compound and duplex, and as I overhaul the steam cylinders I don't see but what it is good for fifty years more. So this question of depreciation seems to me would have to be taken up, to a certain extent, according to local conditions.

From my experience, so far as the length of life of pipe is concerned, I don't see any reason why the pipe in Marlboro should

not last for seventy-five years. I am surprised that any statement should be made that pipe wouldn't last over twenty-five years, for I guess the old cement pipe does better than that. I think fifty years under average conditions would be very low for the life of cast-iron pipe. Of course, the tubercles forming inside cut down your supply some, but so far as the pipe goes, I think good cast-iron pipe under average conditions is good for seventy-five years at least.

MR. R. C. P. COGGESHALL.* Mr. President, perhaps it is digressing a little from this discussion, but I should like to refer a moment to the practice among city councils of applying water-works funds to other purposes. Mr. Chase has had a good deal to do with our accounts in New Bedford, and he is very familiar with them. Our pumping station lot, for instance, which was wholly paid for out of the original water bonds, has been taken almost entirely away by the city council and is now used by other departments of the city, without any credit being given to the water department. The railroad company in raising the grade of their tracks took possession of a part of one of our reservoir lots. The proper award was made, but the city council took good care that it was carried to other accounts. That sort of thing is constantly occurring in connection with water-works matters. In the city of Fall River, for years they took a large slice of the income of the water works and devoted it to other purposes; and in many places the municipality does not contribute one cent to the water department for the water that is used. That was changed in our city two years ago. Now, in order to get at the thing exactly, and I believe in a depreciation charge, it seems to me that the city council itself has got to be educated up to giving proper credits to the water department.

MR. SAMUEL H. MCKENZIE. Mr. President, I should like to inquire if any members present have had experience in cleaning mains.

If they can be successfully cleaned at a reasonable cost, the life of the pipes will be lengthened and the per cent. of depreciation materially lessened.

MR. EDWIN C. BROOKS. We had about 1 800 feet of 6-inch

* Superintendent Water Works, New Bedford, Mass.

pipe cleaned which had been laid for twenty odd years, and with very gratifying results. It was a small matter, and as there happened to be just a little money available for that purpose, we spent it in cleaning the pipe rather than in digging up the street to lay a new main. The cost of this cleaning was about $290.

MR. HARVEY S. CHASE. The question of town accounting as a whole has been referred to. Director Gettemy, of the Statistics Department, under the statutes passed in 1906, now has practical mandatory control over the accounting of cities, although he has not utilized that power as yet; that is, he is working along the lines of least resistance and is suggesting and advising and gradually bringing the towns and cities up to a proper realization of the importance of the matter. I think he is doing it in exactly the right way; but he has mandatory power so that he can compel a city or town at the present time, if he desires, to keep its accounts according to the requirements of the commonwealth. Along that line the developments are going to come, not only for the ordinary accounting of towns, but for the water works of towns and cities, and by a standardization at the center of things here in the Bureau of Statistics a development of accurate and uniform methods will be found for water works, including that question of depreciation. Of that I have no doubt. It will take time, of course, but it is being worked out not only in Massachusetts, but in other states, in Ohio particularly, and in Indiana and in Kentucky, and in various other states.

As to the question of reconstruction, that is to say, when a 4-inch main is to be taken up because it is not large enough, and a 6-inch or an 8-inch is to be laid in the place of it, it is asked how we should handle that in our accounts. We have laid aside monthly, we will say, an amount in the depreciation reserve for mains, which has been growing month by month and year by year, until we have an amount of $25 000, or whatever it may be, reserved. That applies only to mains; that is the depreciation reserve for mains. Aside from that account, we have a depreciation reserve for pumping plant, another depreciation reserve for services; and, in fact, we need just as many depreciation reserves as we have classes of assets, because the percentage of depreciation on each one of those classes of assets is different, as is familiar to all of us,

and as has been stated here. Now, taking the one case, here we have a reserve for mains. On our books in our plant accounts, we have the total cost (which may be subdivided if we desire) of our mains as they now lie in the streets. Now we are going to pull up a portion of that 4-inch pipe, 2 000 feet, or whatever it may be, and replace it by a 6 or 8-inch, and how shall we handle this in our accounts? We know by keeping records what the cost of laying the new pipe is. We charge that immediately to our plant account (on the left), increasing our plant account by so much. We now subtract from the plant account the original cost of the 4-inch main, by crediting the original cost to the plant account, and charge the same amount against the depreciation reserve for mains. In this way we take care of everything, you see, and very simply. We have got a record then of the actual cost of the new pipe which has gone in, and we have also taken out the cost of the old pipe and have charged it up into depreciation reserve, where it belongs.

The balance of these depreciation reserves should, of course, be carried forward from year to year, and should not be closed up at the end of the year. Thus we go on with new credits and new charges from year to year. If we find we are accumulating too much in any one of these depreciation reserves, that is, if we find (after taking obsolescence into account) that the credits are running too big, naturally we will cut down our rates for depreciation per month, but we do it only when we are convinced that the reserve is too big. On the other hand, if it is too small, and our actual expenditures are greater than the amount of our reserve, we will, of course, increase the percentages. I imagine that any decision by Mr. Justice Moody would not interfere with that, if it is properly done, and done frequently enough. I imagine there would not be any trouble with the courts about doing that.

PROCEEDINGS.

March Meeting.

Hotel Brunswick,
Boston, March 9, 1910.

The President, George A. King, in the chair.

The following members and guests were present:

Members.

S. A. Agnew, J. M. Anderson, C. H. Baldwin, A. F. Ballou, L. M. Bancroft, G. W. Batchelder, F. D. Berry, A. E. Blackmer, J. W. Blackmer, C. A. Bogardus, George Bowers, G. A. P. Bucknam, James Burnie, W. L. Butcher, R. D. Chase, H. W. Clark, R. C. P. Coggeshall, M. F. Collins, J. W. Crawford, A. W. Cuddeback, G. W. Cutting, Jr., E. R. Dyer, F. B. Forbes, F. L. Fuller, F. J. Gifford, T. C. Gleason, A. S. Glover, J. A. Gould, F. H. Gunther, R. A. Hale, R. K. Hale, F. E. Hall, J. O. Hall, T. G. Hazard, Jr., M. F. Hicks, H. G. Holden, J. L. Howard, F. M. Hutchinson, E. W. Kent, Willard Kent, Patrick Kieran, F. C. Kimball, G. A. King, N. A. McMillen, D. E. Makepeace, A. E. Martin, John Mayo, F. E. Merrill, G. F. Merrill, H. A. Miller, William Naylor, G. A. Nelson, F. L. Northrop, E. M. Peck, T. A. Peirce, J. L. Rice, Henry Roberts, Ransom Rowe, P. R. Sanders, A. L. Sawyer, S. P. Senior, E. M. Shedd, C. W. Sherman, H. O. Smith, W. E. Smith, G. H. Snell, J. T. Stevens, E. L. Stone, W. F. Sullivan, C. N. Taylor, H. L. Thomas, R. J. Thomas, W. H. Thomas, D. N. Tower, C. H. Tuttle, W. H. Vaughn, C. K. Walker, R. S. Weston, G. E. Winslow. — 78.

Associates.

Anderson Coupling Company, by Charles E. Pratt; Ashton Valve Company, by C. W. Houghton; Builders Iron Foundry, by A. B. Coulters and F. N. Connet; Chapman Valve Manufacturing Company, by H. L. DeWolf; Darling Pump and Manufacturing Company (Ltd.), by H. H. Davis; F. H. Hayes Machinery Company, by F. H. Hayes; Hersey Manufacturing Company, by Albert S. Glover and Walter A. Hersey; Lead Lined Iron Pipe Company, by Thomas E. Dwyer; Ludlow Valve Manufacturing Company, by Arthur R. Taylor; H. Mueller Manufacturing Company, by G. A. Caldwell; National Meter Company, by C. H. Baldwin and J. G. Lufkin; Neptune Meter Company, by H. H. Kinsey; Norwood Engineering Company, by W. G. Ryan and H. W. Hosford; Pittsburg Meter Company, by F. L. Northrop; Rensselaer

Manufacturing Company, by Charles L. Brown; Ross Valve Manufacturing Company, by William Ross; A. P. Smith Manufacturing Company, by F. N. Whitcomb; Thomson Meter Company, by E. M. Shedd; Union Water Meter Company, by W. F. Hogan. — 23.

GUESTS.

Albert S. Benson, chemist, East Greenwich, R. I.; Charles R. Hildred, Somerville, Mass.; Harry L. Whitney, W. H. Larcom, Beverly, Mass.; E. B. Curney, W. H. Putnam, Lowell, Mass.; George H. Stevens, Dracut, Mass., and D. H. Hall, Bridgeport, Conn. — 8.

The Secretary read the application of Harry L. Whitney, city engineer of Beverly, Mass., for membership in the Association, properly endorsed and recommended by the Executive Committee. On motion of Mr. Peirce, the Secretary was directed to cast one ballot in favor of the applicant, and he having done so, Mr. Whitney was declared elected a member of the Association.

The President then called for any practical questions for discussion.

To the following question, submitted by Mr. Rowe, "Is it practicable or necessary to clean water mains in New England? Can water mains be cleaned by machine?" there were no answers.

A question in regard to the vibrations or water hammer in pumps was discussed by G. F. Merrill, S. A. Agnew, C. N. Taylor, F. L. Fuller, H. L. Thomas, F. H. Hayes, A. E. Martin, and R. C. P. Coggeshall.

Mr. Desmond FitzGerald, civil engineer, of Boston, then addressed the meeting upon the subject, "Medieval Times of Germany," illustrating his remarks with stereopticon slides.

Mr. H. W. Clark, chemist of the Massachusetts State Board of Health, Boston, then read a paper entitled, "Double Filtration of Polluted Waters."

THE PRESIDENT. There is a question in my mind whether the members understand that headquarters are open every day to members of this Association. It might appear from our notice that the room is open only the day of the meeting, but that room is open to you all the time, every day, and you are at liberty to use it as you wish all through the week.

Adjourned.

April Meeting.

Allyn House,
Hartford, Conn., April 13, 1910.

The President, George A. King, in the chair.

The following members and guests were present:

Members.

S. A. Agnew, C. H. Baldwin, A. F. Ballou, E. W. Bemis, F. D. Berry, J. F. Bigelow, A. E. Blackmer, J. W. Blackmer, C. A. Bogardus, E. C. Brooks, L. G. Carleton, C. F. Chandler, J. H. Child, M. F. Collins, H. R. Cooper, G. K. Crandall, E. D. Eldredge, E. A. Fisher, J. A. Fitch, E. V. French, T. C. Gleason, R. A. Hale, R. K. Hale, F. E. Hall, J. C. Hammond, Jr., A. E. Hansen, W. H. Hart, A. R. Hathaway, Allen Hazen, A. B. Hill, W. E. Johnson, Willard Kent, G. A. King, F. C. Kemble, J. J. Kirkpatrick, H. O. Lacount, B. C. Little, E. E. Lochridge, Daniel MacDonald, S. H. McKenzie, T. H. McKenzie, A. E. Martin, W. E. Maybury, J. A. Newlands, F. L. Northrop, O. E. Parks, E. M. Peck, W. H. Richards, Henry Roberts, H. W. Sanderson, A. L. Sessions, E. M. Shedd, C. W. Sherman, G. A. Stacy, W. F. Sullivan, J. L. Tighe, J. A. Tilden, J. H. Walsh, H. L. Whitney, I. S. Wood. — 60.

Associates.

Anderson Coupling Company, by C. E. Pratt and G. W. Hayden; Builders Iron Foundry, by A. B. Coulters; Chapman Valve Manufacturing Company, by Robert Shirley; Darling Pump and Manufacturing Company (Ltd.), by H. H. Davis; Gamon Meter Company, by C. A. Vaughan; Glauber Brass Manufacturing Company, by S. S. Freeman; Hersey Manufacturing Company; by J. A. Tilden; International Steam Pump Company, by Samuel Harrison, Lead-Lined Iron Pipe Company, by T. W. Dwyer; Charles Miller & Son Company, by Charles F. Glavin; H. Mueller Manufacturing Company, by A. C. Pilcher; National Meter Company, by C. H. Baldwin and J. G. Lufkin; Neptune Meter Company, by T. D. Faulks; Pittsburg Meter Company, by F. N. Northrop; Rensselaer Manufacturing Company, by C. L. Brown and F. S. Bates; A. P. Smith Manufacturing Company, by F. N. Whitcomb; Thomson Meter Company, by E. M. Shedd; Union Water Meter Company, by F. E. Hall; R. D. Wood & Co., by W. F. Woodburn. — 22.

Guests.

H. L. Haines, water commissioner, Springfield, Mass.; William C. Pollett, A. E. Lavery, and D. H. Hall, assistant superintendent, Bridgeport, Conn.; William R. Edwards, Paterson, N. J.; G. M. Clukas, Cambridge, Mass.; A. W. Jepson, Bristol, Conn.; Charles L. McNeil and Isaac W. Brooks, Torrington, Conn.; William S. Scranton, superintendent, Durham, Conn.; T. A. Collins, Philadelphia, Penn.; Nelson D. Merwin, Ezra Cutting, A. C. Hall, Mr. Greenwood, L. W. Goodrich, H. L. Phillips, Hon. E. L. Smith, F. S. Cary, Ferdinand

Richton, F. C. Sumner, John L. Down, Shiran Morris, James F. Shaughnessey, Hartford, Conn.; Ernest Farrell, Holyoke, Mass.; Robert K. Tomlin, Jr., *Engineering Record*, New York City; Anthony Adams, superintendent, Stafford Springs, Conn.; J. P. Steele, C. A. Cook, Marlboro, Mass.; James J. Walsh, Meriden, Conn.; E. B. Bronson, Winsted, Conn.; E. L. Burnap and A. S. Comstock, Norwich, Conn. — 33.

The President called the members to order and presented his Honor Mayor Smith, of Hartford, who spoke as follows:

MAYOR SMITH. *Mr. President and Gentlemen of the New England Water Works Association,* — It is extremely pleasant for me to be here to welcome you to Hartford in the name of the city. It may not look so, but it is a fact, that I have been connected with the water works of the city of Hartford for about seven years. I was associated with this body of gentlemen on my right, who represent the Water Department here at this meeting, and for seven years I helped them, doing what I could to provide the city with a pure water supply. It was one of the vicissitudes of human experience that last year I retired from the Water Board and went back to the silken ease of my library in the classic shades of the Trinity campus, and took up the study of Epictetus and Allen Hazen on filtered water supplies, to calm my disturbed spirit.

The city of Hartford is very much interested at the present moment in the water question. If you gentlemen are to discuss that question you will have a very interested audience throughout the city. If you are going to discuss the forestry question, as I understand from your President you may, you will have an equally interested audience, for some of us are not yet out of the woods. This is the very first convention that I have addressed as mayor of this city, and no convention would I prefer to address rather than one that is interested in the work that I have been interested in. I trust that your visit here will be as pleasant as the most enthusiastic of you could desire. We are proud to have you here, and so far as in our power lies we will try to make you thoroughly welcome.

The President, after thanking the mayor for his presence and for his words of welcome, announced that it had seemed desirable to change the date of the September meeting at Rochester from September 14–16 to September 21–23, just one week later. He

then called upon the Secretary to present the applications for membership.

The Secretary read the following list of applicants:

Active. — J. Walter Ackerman, superintendent of the Municipal City Works, Auburn, N. Y.; Raymond W. Ferris, Columbus, Ohio, sanitary engineer, has been engaged in the engineering departments of the State Boards of Health of Massachusetts and Ohio; Herman K. Higgins, Boston, has been engaged in sundry water supply projects, including design of dams, channels, and filters at Gatun, Canal Zone; William H. Wilson, Burlington, Vt., superintendent of Burlington Filtration Plant; Cyrus C. Babb, Augusta, Me., district engineer, United States Geological Survey; R. J. Sandford Sly, Toronto, Ont., civil engineer; James J. Walsh, Meriden, Conn., superintendent of the Meriden Water Works; Leonard H. Davis, Sault Ste. Marie, Ont., chief engineer, Lake Superior Power Company, the Michigan-Lake Superior Power Company, the Tagona Water and Light Company; Edwin L. Burnap, Norwich, Conn., superintendent water works; George A. Carpenter, Pawtucket, R. I., city engineer; John K. Barker, Springfield, Mass., engaged in general engineering, mill, and hydraulic work; Albert S. Comstock, Norwich, Conn., water commissioner; Isaac W. Brooks, Torrington, Conn., president of water company. — 13.

Associate. — George M. Clukas, Cambridge, Mass., with the Pennsylvania Cement Company; American Asphaltum and Rubber Company, Chicago, Ill., manufacturers of "Pioneer" mineral rubber pipe coating and "Pioneer" reservoir waterproofing asphalt; Fred A. Houdlette & Son, Inc., Boston, cast-iron pipe and structural materials (reinstated). — 3.

On motion of Mr. Brooks, of Cambridge, the Secretary was directed to cast the ballot of the Association in favor of the candidates named, and he having done so, they were declared elected.

Under the head of "Topical Discussion," which was next on the program, the question, "Is it practical or necessary to clean water mains in New England? Can water mains be cleaned by machine?" was considered by Mr. E. C. Brooks, Mr. F. A. McInnes (by letter), Mr. McKenzie, Mr. Kemble, Mr. Robert Shirley, Mr. Allen Hazen, and Prof. Edward W. Bemis. Then Mr. George A. Stacy brought up the subject of the comparative advantages of a round multiple and a straight reading register for a water meter. Mr. J. A. Tilden, Mr. J. C. Hammond, Jr., Mr. C. W.

Sherman, and the President also spoke on the subject. Mr. Kemble asked for information as to the difference in the effect of an alternating current and a direct current in producing electrolysis, but no one replied to his question.

Mr. E. E. Lochridge opened the discussion on "Secondary Water Supplies, Their Dangers and Value." He was followed by Mr. William F. Sullivan, Mr. E. C. Brooks, Mr. John J. Kirkpatrick, Ermon M. Peck, Robert Shirley, George A. Stacy, Edward V. French, M. F. Collins, Prof. Edward W. Bemis, and J. H. Child.

Mr. L. W. Goodrich, Forester for the Water Department of Hartford, read a paper on "Forestry." The subject was discussed by Professor Hawley, Mr. E. B. Bronson, and Mr. William F. Sullivan.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Wednesday, March 9, 1910.

Present: President George A. King and members Frank A. McInnes, Lewis M. Bancroft, George W. Batchelder, Robert J. Thomas, Richard K. Hale, Ermon M. Peck, Michael F. Collins, and Willard Kent.

Voted: That the Committee on Annual Convention be invited to send a representative to attend the April meeting of the Association at Hartford, Conn., at the expense of the Association.

Voted: That Mr. William F. Woodburn be and hereby is appointed a Committee on Exhibits at the next Annual Convention with authority to appoint an assistant.

Voted: That the program of the April meeting contain notice that applications for membership will be received and acted upon at that time; also of any other business that may appear necessary prior to issuance of program.

Voted: That the Secretary be and hereby is authorized to make arrangements for hotel accommodations for the next winter's meetings of the Association.

Voted: That Messrs. George W. Batchelder and Robert J. Thomas be and hereby are constituted a Committee on Transportation for the next Annual Convention.

The President, Committee on "Boston 1915," reports that he has performed his duties, and upon his recommendation it was

Voted: That Mr. Frank A. McInnes be and hereby is made a committee to represent the Association at the future meetings of "Boston 1915."

Adjourned.

WILLARD KENT, *Secretary.*

BOSTON, MASS., March 24, 1910.

Meeting of the Executive Committee at headquarters, 715 Tremont Temple, at 2 o'clock P.M., at the call of the President.

Present: President George A. King and members Robert J. Thomas, Lewis M. Bancroft, Frank A. McInnes, Ermon M. Peck, Michael F. Collins, Richard K. Hale, and Willard Kent.

A letter was read from Albert H. Wehr, chairman of Committee of American Water Works Association on Uniform Water Works Accounts and Reports, inviting the Association to send a representative to attend a conference with the Hon. LeGrand Powers, chief statistician of the Bureau of the Census, and others.

It was voted that the invitation be accepted and President King was appointed a committee to attend said conference, his expenses to be borne by the Association.

Adjourned.

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee, April 13, 1910, at Hotel Allyn, Hartford, Conn.

Present: President George A. King and members Edwin C. Brooks, George A. Stacy, Michael F. Collins, Irving S. Wood, Ermon M. Peck, Richard K. Hale, and Willard Kent.

Thirteen applications for active membership were received, as follows: James J. Walsh, superintendent water works, Meriden, Conn.; Edwin L. Burnap, superintendent water department, Norwich, Conn.; Isaac W. Brooks, president water company, Torrington, Conn.; John K. Barker, civil engineer, Springfield, Mass.; R. J. Sanford Sly, civil engineer, Toronto, Ont.; Herman K. Higgins, consulting engineer, Boston, Mass.; Cyrus C. Babb, district engineer state water storage commission, Augusta, Me.; William H. Wilson, superintendent filtration plant, Burlington, Vt.; Leonard H. Davis, chief engineer, The Lake Superior Power Company, Sault Ste. Marie, Ont.; J. Walter Ackerman, superintendent municipal water works, Auburn, N. Y.; Albert S. Comstock, water commissioner, Norwich, Conn.; George A. Carpenter, city engineer, Pawtucket, R. I.; and Raymond W. Ferris, assistant engineer, Ohio State Board of Health, Columbus, Ohio.

Two applications for associate membership were received as follows: Pennsylvania Cement Company, Boston, Mass., and The American Asphaltum and Rubber Company, Chicago, Ill.

One application for reinstatement to associate membership was received, as follows: Fred A. Houdlette & Son, Inc., Boston.

Voted: That it be recommended to the Association that the above-named applications be granted.

On motion of Mr. Stacy it was voted: That in order to better facilitate the arrangements for accommodations, the date of the Annual Convention of this Association for the present year, to be held at Rochester, N. Y., be and hereby is changed from that previously fixed to September 21, 22, and 23.

Voted: That fifteen dollars ($15) be and hereby is appropriated for expenses of Joint Committee on Society House.

Voted: That it is the opinion of the Executive Committee that the New England Water Works Association should lease quarters in the proposed Society House at an expense not exceeding five hundred dollars ($500) per annum.

Adjourned.

WILLARD KENT, *Secretary.*

OBITUARY.

Dennis H. Gilderson.

Died March 14, 1910.

Mr. Gilderson, the son of Mr. and Mrs. William Gilderson, was born in Parsboro, N. S., in 1860. After leaving the public schools, he became a constructor for the C. L. Goodhue and Burnie Company, of Springfield, with whom he was associated for many years. In 1890 Mr. Gilderson built the water works at Bradford, and, on their completion, became superintendent. He held this position until the town was annexed to Haverhill, when he entered the office of the superintendent of that town. He became superintendent of the Haverhill Water Works in 1897, which position he held until his death.

Mr. Gilderson was married in 1886 to Miss Mary Furey, of Thompsonville, Conn., who with two sons survives him.

Mr. Gilderson was a charter member of the Bradford Lodge, A. O. U. W., a member of the Haverhill Lodge of Elks, of the Palestine Lodge of K. of P., and of the Holy Name Society.

Mr. Gilderson was elected a member of the New England Water Works Association on September 11, 1895.

BOOK REVIEWS.

TEXT-BOOK ON HYDRAULICS. By George E. Russell, Assistant Professor of Civil Engineering, Massachusetts Institute of Technology. 6 x 9½ inches, vii + 183 pages. 124 illustrations in the text. New York: Henry Holt & Co. Cloth, $2.50.

As the author states in the preface, this book is intended for a text-book for a short course in hydraulics, where time will not permit of an extended study of the whole subject.

If it is acknowledged that a text-book for such a course should be a discussion of the fundamental principles only, leaving the applications to be supplied by the instructor, rather than a more or less complete reference book for use after the services of the instructor are no longer available, this work will be found most useful.

The subjects treated include definitions and units of measure, a discussion of the fundamental formulæ of hydrostatics, motion of liquids, discharge through orifices, weirs, tubes, pipes, and channels, and a short chapter on the dynamic action of jets, the pressure in pipe bends, and water hammer. The appendix contains the usual tables of weights, velocity heads, and coefficients.

The author omits turbines, pumps, and other hydraulic machinery, as well as the measurement of the flow of rivers.

The discussions are logically presented and well written. There are numerous lists of references to the more important of the subjects, and many problems to illustrate the principles considered.

The book is an exceedingly good presentation of the fundamental theories of hydraulics, but it would not be as useful for a reference book as a more extended treatise on the subject.

THE FLOW OF WATER: A NEW THEORY OF THE MOTION OF WATER UNDER PRESSURE AND IN OPEN CONDUITS AND ITS PRACTICAL APPLICATION. By Louis Schmeer, Civil and Irrigating Engineer. 6 x 9½ inches, vii + 228 pages. Text illustrations and tables. New York: D. Van Nostrand Company. Cloth, $3.00 net.

The author states in the preface that the book is the outcome of a series of investigations to find a simple expression for the phenomenon of the flow of water in irrigating channels.

The author first discusses the variation of the velocity with the mean hydraulic radius, and the variation of the coefficient in the Chazy formula with the roughness of the wetted perimeter and with the velocity. With the aid of observed data from various sources, he then combines these relations into an exponential equation. By varying the exponent of this equation, and a

coefficient of roughness, this equation is said to fit all conditions of flow in pipes, conduits, or open channels. The complications involved may, perhaps, be judged by such expressions as "find the square root of the quotient and multiply by the seventeenth root of the square root," and the use of such exponents as the nine-forty-thirds, eighteen-seventeenths, and others. In spite of tables giving many values of these exponents, the solution of the equation under practical conditions is none too simple. There is, moreover, considerable doubt whether there are enough data on the flow of water in open channels to warrant the use of such an equation.

The author then discusses the general relations between the velocity discharge and depth of water in the form of section most favorable to flow, giving many tables of roots and powers. A short chapter on weirs follows, containing little new material. The appendix contains a discussion of the variation of the coefficient C with the slope, the author's formula expressed in metric measure, and a discussion of the most economical diameter of pipe.

As a whole, the method has little to commend it for practical work.

THE WATER SUPPLY, SEWERAGE, AND PLUMBING OF MODERN CITY BUILDINGS. By Wm. Paul Gerhard, Civil Engineer. 8 vo., xxxii + 491 pages, with 214 text illustrations, 15 tables, and 25 diagrams. New York: John Wiley & Sons. Cloth, $4.00 net.

As the author states in the preface, this book is the outgrowth of various lectures, revised and enlarged, with the addition of many tables, diagrams, and illustrations. The chapters are so written that each one is complete in itself, although this method involves numerous repetitions.

The book is well illustrated with photographs and drawings and cuts from manufacturers' catalogues, and its value is greatly increased by numerous, tables and diagrams of capacities and discharge of tanks, drains, service pipes, etc. Some of these diagrams could have been arranged a little more conveniently, and in some of them the coefficients used are not clearly stated. For example, in the table of discharge of orifices, nothing is said as to what coefficient should be used. It would be inferred from the table heading that the discharges could be used as given, whereas the values are the theoretical ones and are, therefore, almost twice as great as those commonly found in practical work.

The first two chapters deal with the essential features of the hydraulic and sanitary engineering of buildings, and contain a very complete description, fully illustrated, of the many sanitary fixtures and appliances in common use.

In the third chapter the author describes the plumbing systems that were formerly used, and the ones generally prescribed at the present time by building regulations and health boards. He then outlines an advanced system, which he has used in his own work, whenever unhampered by the regulations, which he considers much superior to the other systems because of its greater simplicity.

Chapter IV deals with plumbing in its relation to disease, and to the municipal control of plumbing. In this chapter the author points out that even if, as the best sanitarians claim, sewer air *per se* does not directly cause specific disease, it probably has considerable effect on the general health, and, therefore, it is essential to have plumbing correctly arranged. He also takes up the question as to which is the proper city department to inspect the installation of plumbing, and discusses some of the rules and regulations.

Chapters V and VI give a very complete treatment of the methods of supplying water to houses and city buildings, and contain numerous hydraulic tables and diagrams.

In Chapter VII the author discusses the maintenance of pipe system for sewage, gas, and water; with the methods of cleaning and flushing, the care of valves, faucets, and hydrants, and the protection of pipes against freezing.

Chapter VIII deals with plumbing rules, drawings, plans, and specifications and the quality of materials employed in plumbing, drainage, sewerage, and water supply. It seems to be largely a summary of preceding chapters.

In the appendix the author gives a very complete list of definitions of terms commonly used in sanitary engineering, an interesting historical sketch of the development of the art of plumbing, and a specification reminder, which will be found to be of considerable value in preparing specifications.

The book is unquestionably of considerable value to the architect, builder, and sanitary engineer, and will prove most interesting reading to any one interested in the subject, as well as to town officials who have to prepare or enforce plumbing regulations. Complete as the book is, it seems a pity that some mention of costs, and more data on the quantities of water and the number of fixtures to be provided, could not have been included.

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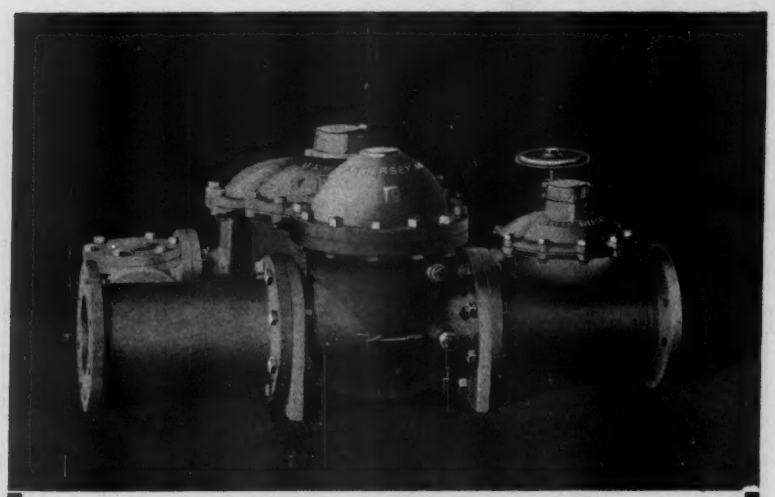

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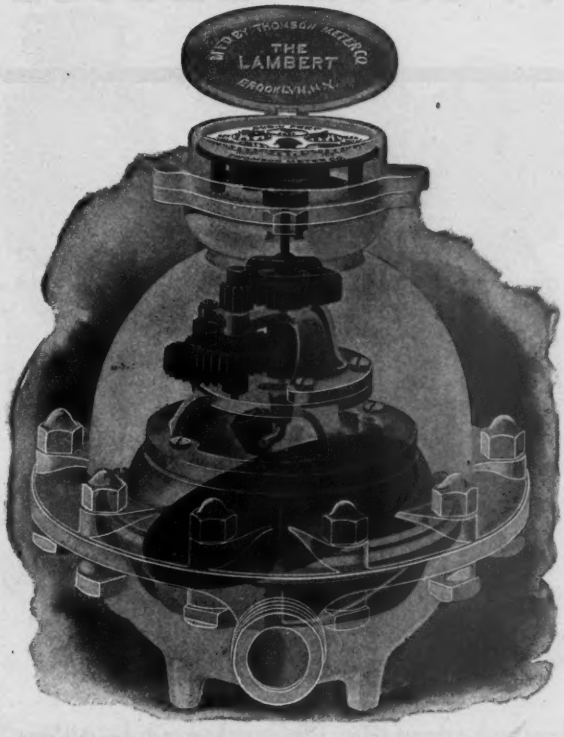

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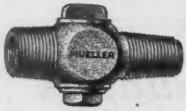

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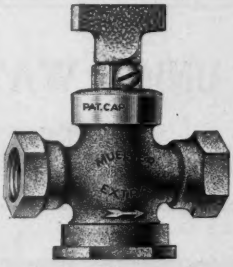

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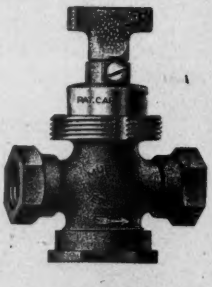

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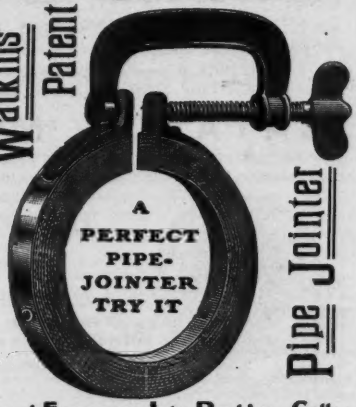

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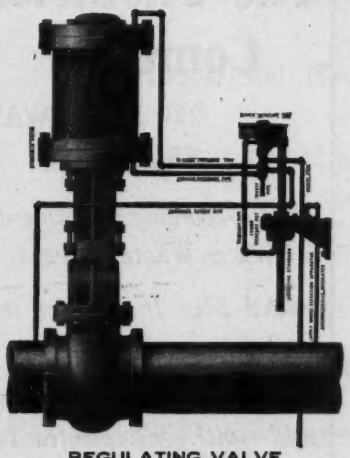

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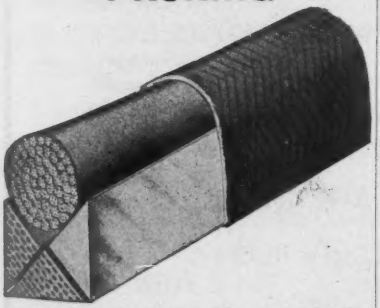

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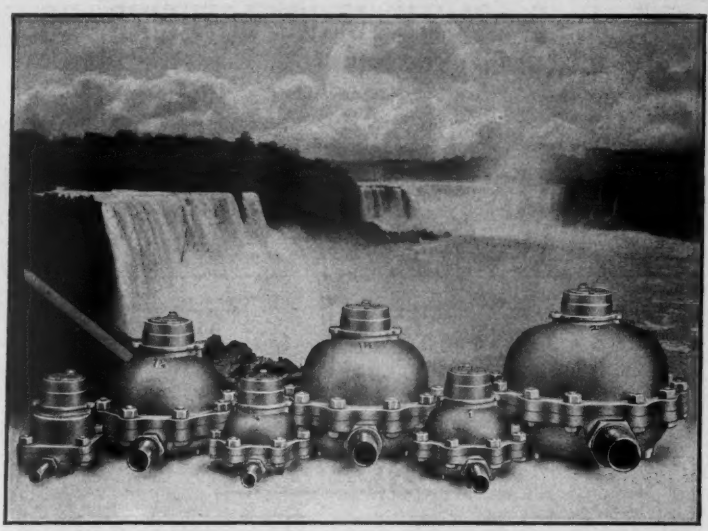

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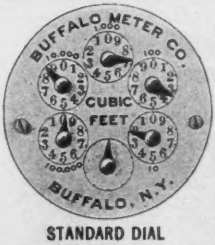

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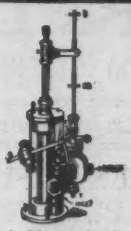

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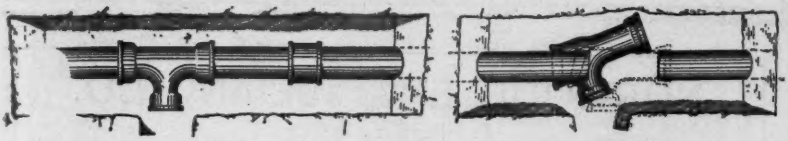

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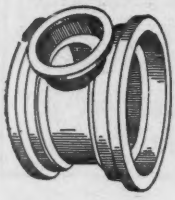

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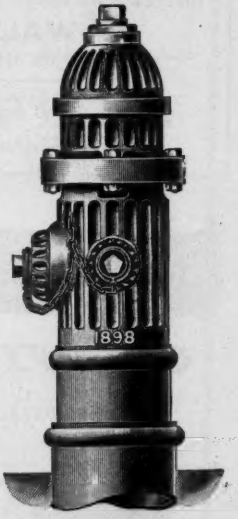

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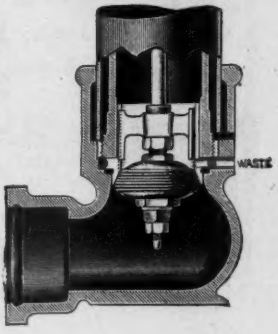

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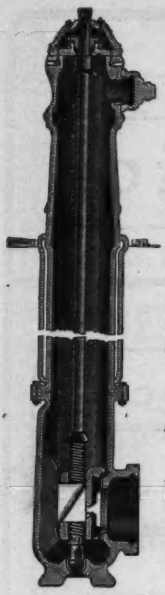

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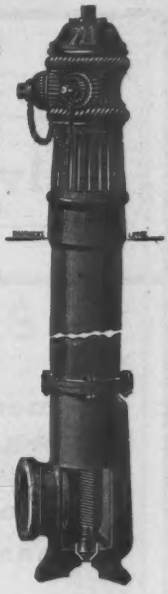

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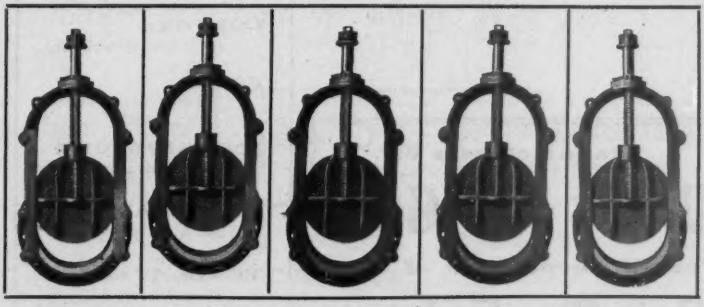

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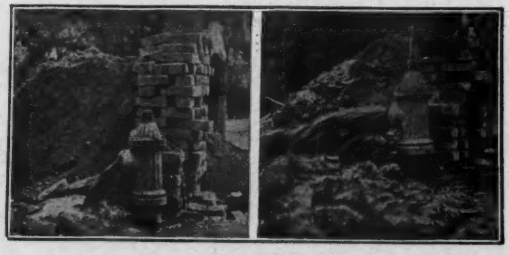

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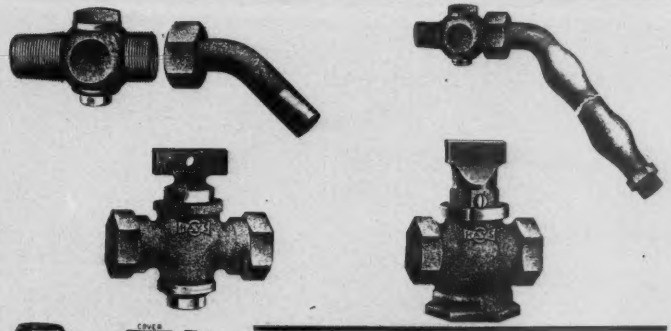

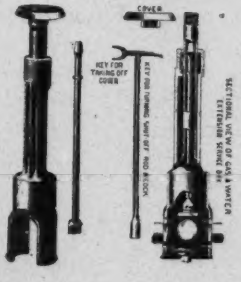

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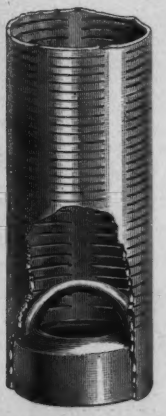

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